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(54) MASK FOR REACTIVE ION ETCHING

(57)Abstract:

PROBLEM TO BE SOLVED: To enable simple etching with high resolution and accuracy by constituting a mask of one kind of Ti, Mg, Al, Ge, Pt, Pd single metals and alloys or compds. essentially comprising one or more of these elements.

SOLUTION: Ti, Mg, Al, Ge, Pt, Pd or alloys or compds. essentially comprising these elements hardly react with CO-NH3 gas plasma so they are suitable as a mask material. Especially Ti and an alloy or compd. essentially comprising Ti are excellent. By using a mask comprising these materials, redeposition of contaminant on the objective material for etching is not caused, and sharp and accurate etching is possible. The objective material of etching is preferably a magnetic material permalloy or the like. When a resist film is used for pattern forming, various kinds of org. polymer films are used. The etching plasma gas is preferably a mixture gas of CO and a nitrogen-contg. compd. such as NH3 and amines.

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CLAIMS

[Claim(s)]
[Claim 1] a mask for reactive ion etching by plasma -- it is -- titanium, magnesium, aluminum, germanium, platinum, palladium, and these each -- or a mask for reactive ion etching characterized by consisting of at least one sort in an alloy which uses two or more sorts as a principal component, or a compound.
[Claim 2] A mask of claim 1 which is a mask for reactive ion etching by plasma of mixed gas of a carbon monoxide and a nitrogen-containing compound.
[Claim 3] A mask of claims 1 or 2 which are the masks for reactive ion etching at the time of etching a magnetic material.
[Claim 4] A mask for reactive ion etching which is a mask for reactive ion etching by plasma of mixed gas of a carbon monoxide and a nitrogen-containing compound, and is characterized by consisting of alloys which use silicon or silicon as a principal component.
[Claim 5] A mask for reactive ion etching characterized by being a mask for reactive ion etching by plasma of mixed gas of a carbon monoxide and a nitrogen-containing compound, consisting of compounds of silicon, being arranged on a pattern from a resist film, and lift off considering as a mask.
[Claim 6] A mask of claims 4 or 5 which are the masks for reactive ion etching at the time of etching a magnetic material.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] Invention of this application relates to the mask for reactive ion etching. The magnetic head by which invention of this application is used for write-in read-out to a magnetic disk in more detail, The micro transformer, micro inductor which are included in a magnetic integrated circuit, To a magnetic sensor and a pan, a spin dispersion magneto-resistive effect element, a spin bulb element, A ferromagnetic tunnel junction element, a spin electric field effect element, spin diode, groups, such as a spin transistor, -- the quantum effect MAG device and a thin film magnet -- It is related with the new mask for reactive ion etching characterized as a useful dry etching system of a magnetic material etc. to manufacture of the component part of very small machines, such as a magnetostriction actuator, etc.
[0002]
[Description of the Prior Art] Generally minute semiconductor devices and magnetic cells, such as a VLSI, are manufactured combining two processes of lithography technology and etching technology. Lithography technology is technology which makes a detailed graphic form to films, such as a resist film applied to the surface of the quality of a workpiece (the thin film of a semiconductor, and thin film of the magnetic substance), and there are photolithography technology exposed using ultraviolet rays, electron-beam-lithography technology exposed using an electron ray, and ionic line lithography technology further exposed using an ionic line in this.
[0003] Moreover, etching technology is technology which imprints the resist pattern produced with lithography to the semiconductor thin film and magnetic-substance thin film of the quality of a workpiece, and produces an element. There are the wet etching method, the argon ion milling method, and a reactive-ion-etching method in etching technology. In these etching methods, it can imprint most correctly the pattern produced with lithography, is most suitable for micro processing, and a reactive-ion-etching method has a quick etching speed, and is a most excellent method. The large-scale integrated circuit of a semiconductor and semiconductor memory are actually made by this method.
[0004] By placing a workpiece and adding electric field into the plasma of reactant gas, a reactive-ion-etching method is the method of stripping off the atom of the surface of a workpiece one by one physically in a chemical list with the ion which carries out incidence perpendicularly to the surface of a workpiece, and different direction-processing which cuts deeply the part which is not covered with a mask perpendicularly along the boundary of a mask is possible for it. Therefore, it is the method of imprinting a detailed sharp configuration. By the reactive-ion-etching method, chemical active species, such as ion of the reactant gas which occurred in the plasma, and a radical, adsorb on the surface of a workpiece, a chemical reaction is considered as a workpiece, and a surface reaction layer with low binding energy is formed first. Then, since the surface of a workpiece is exposed to the perpendicular impact of the cation accelerated by electric field in the plasma, the surface reaction layer in which association loosened is stripped off by a sputtering operation of ion or evaporation. Thus, a reactive-ion-etching method is a process which a chemical operation and a physical operation take place to

coincidence, and advances. Therefore, the selectivity of etching only specific material is acquired and the anisotropy of cutting deeply at right angles to the surface of the quality of a processing object to coincidence is acquired.
[0005] However, by one side, to a magnetic material, a reactive-ion-etching method effective for a long time is not found, but the wet etching method and the argon ion milling method are actually used to a magnetic material, and, thereby, the thin film magnetic head, the magnetic sensor, the micro transformer, etc. are manufactured. Such a condition in a magnetic material delayed orientation of high density integration remarkably compared with the semiconductor in the detailed-ized list of the magnetic substance, and had become the failure of development.
[0006] The reason with difficult reactive ion etching to a magnetic material The magnetic material which is using the transition-metals element as the principal component Former All the etching gas developed for semiconductor materials (For example) [CF4, CCl4,] [CCl2] F2, CClF3, CBrF3 and Cl2, C two F6, C three F8, and C4 -- F10, CHF3, C two H2, SF6, SiF4, BCl3, PCl3, SiCl4, HCl, and CHClF2 etc., although it reacts in a magnetic material and the plasma Since binding energy generated large material far as compared with the resultant of a semiconductor material, it was hard to receive a spatter operation, therefore etching was not made.
[0007] Then, efforts to investigate not an analogy but the new reactive-ion-etching reaction from semiconductor technology were made, and the method using the mixed-gas plasma of carbon monoxide (CO) gas and ammonia gas (NH3) was invented by the artificer of this invention etc. recently. This method By the activity radical of CO A transition-metals carbo nil ghost (Fe -- (-- CO --) -- five -- nickel -- (-- CO --) -- four -- Co -- two -- (-- CO --) -- eight -- Mn -- two -- (-- CO --) -- ten -- Cr -- (-- CO --) -- six -- V -- (-- CO --) -- six -- Mo -- (-- CO --) -- six -- W -- (-- CO --) -- 6) is made to generate on the surface of the magnetic material which uses as a principal component the transition-metals element which is a workpiece. It is making to strip off and etch them according to the evaporation in the inside of a vacuum, or the spatter operation by ion into the principle. A transition-metals carbo nil ghost is a compound with the only small binding energy in the inside of transition metals. However, CO gas is CO2 by disproportion reaction in the plasma. Since C atom which separated reacts with a transition-metals element and stable transition-metals carbide is generated, without introduced CO gas contributing to a reaction in order to decompose into C, as for an etching reaction, not happening is common. NH3 Gas shows the property to delay the above-mentioned disproportion reaction, under existence of a transition-metals element, and is CO gas and NH3. The target reactive ion etching advances in the plasma of the gas which carried out equivalent mixing of the gas mostly.
[0008] By the method based on this principle, implementation of reactive ion etching, such as a permalloy (Fe-nickel alloy) of a magnetic material, a Co-Cr alloy, and Fe, is checked. Thus, SiO2 formed by the sputtering method in the former as mask material which cannot undergo this etching reaction easily for etching by the CO-NH3 mixed-gas plasma although the outstanding reactive-ion-etching method for a magnetic material is found out and future technical development is just going to be expected By having used the film, the problem that that process tolerance and productivity had constraint was left behind.
[0009] If this conventional process is illustrated, it will become as drawing 2 . As the gestalt of a start is shown in drawing 2 (a), on a suitable substrates material, such as Corning 7059 glass substrate (1) The magnetic alloy of the quality of a processing object, for example, a permalloy etc., (nickel-Fe alloy) (2) is formed by the sputtering method. For example, the amorphous carbon film (4) of an electrical conducting material is formed for the quartz (SiO2) thin film (3) used as a mask material on it by the sputtering method on it, respectively, and the resist (5) of an electron ray film is further applied with a spin coat method etc. Here, an amorphous carbon film (4) is a conductive layer required since the quality of an object is not charged in case electron beam lithography is carried out, and this is SiO2. It is the film which is needed since (3) is an insulating material. As shown in drawing 2 (b), a desired graphic form is formed in a resist by electron beam lithography and the development. An amorphous carbon layer is etched by using a resist graphic form as a mask by oxygen ion etching after that, and it is SiO2. A film is exposed in accordance with a graphic form (drawing 2 (c)). Next the plasma of for example, 4

fluoride [carbon] (CF4) gas is used, and it is SiO2. It etches and is the graphic form SiO2 It imprints on a film. CF4 Ion etching is SiO2. Since it is effective, change is not given to the permalloy of the quality of a processing object made into the purpose (drawing 2 (d)). SiO2 obtained as mentioned above CO-NH3 which used the graphic form as the mask and described it previously By the reactive-ion-etching method using the mixed-gas plasma, it is SiO2. The imprinted graphic form is imprinted to a permalloy. A resist film and an amorphous carbon film are also removed by coincidence by etching in this process, and it is SiO2. An imprint is completed in the form which remains on the graphic form of a permalloy (drawing 2 (e)). Micro processing by reactive ion etching, such as a permalloy (Fe-nickel alloy) of the magnetic material by this method, a Co-Cr alloy, and Fe, is performed until now.

[0010] However, it not only has the trouble that the above process is complicated and productivity is bad, but since an imprint was performed twice, it had the trouble that a high precision of an imprint graphic form was not acquired. This method is a method of finally leaving the graphic form corresponding to the portion which was not exposed with an electron ray, and gives the graphic form which reversed the graphic form exposed with the electron ray as a result, i.e., a negative graphic form. However, in the process which produces the complicated detailed structure of the magnetic substance, to acquire the graphic form (positive graphic form) corresponding to the portion which carried out electron beam lithography is also needed.

[0011] Invention of this application aims at offering the process technology using the new mask material and this new which are made as what solves such a problem of the conventional technology, make etching possible in simple and high resolution and a high precision, and make it possible to produce a positive graphic form to coincidence.

[0012]

[Means for Solving the Problem] a mask for reactive ion etching according to plasma as that to which invention of this application solves the above-mentioned technical problem -- it is -- titanium, magnesium, aluminum, germanium, platinum, palladium, and these each -- or a mask for reactive ion etching (claim 1) characterized by consisting of at least one sort in an alloy which uses two or more sorts as a principal component, or a compound is offered.

[0013] Moreover, it also offers this invention that it is a mask for reactive ion etching at the time of etching that it is a mask for reactive ion etching by plasma of mixed gas of a carbon monoxide and a nitrogen-containing compound (claim 2) and a magnetic material about the above-mentioned mask (claim 3). Invention of this application is a mask for reactive ion etching by plasma of mixed gas of a carbon monoxide and a nitrogen-containing compound further again. A mask for reactive ion etching characterized by consisting of alloys which use silicon or silicon as a principal component (claim 4), It is a mask for reactive ion etching by plasma of mixed gas of a carbon monoxide and a nitrogen-containing compound similarly. A mask for reactive ion etching characterized by consisting of compounds of silicon, being arranged on a pattern from a resist film, and lift off considering as a mask (claim 5), Considering as a mask for reactive ion etching at the time of etching a magnetic material (claim 6) also provides a list with these.

[0014]

[Embodiment of the Invention] The mask material conventionally used mainly by semiconductor technology is the resist itself which is polymeric materials. However, various kinds of macromolecule resists are CO-NH3. Consumption does not play a role of a mask greatly in the gas plasma. A compound is CO-NH3 to the alloy list which makes a principal component metallic elements, such as Cr, W, Mo, Mn, Nb, Ta, Fe, Ru, Os, Co, Rh, Ir, nickel, Cu, Ag, Au, Ga, In, and Sn, and them. It reacts with the gas plasma and these selves are etched by sputtering operation, and since it exhausts, as a mask material, it is not suitable. Moreover, vacuum-proof nature is bad and the alloy or compound which makes Zn, Cd, Pb, or them a principal component is not suitable as a mask material. On the other hand, the alloy or compound which makes Pd and them a principal component at Ti, Mg, aluminum, Si, germanium, Pt, and a list is CO-NH3. It was hard to react with the gas plasma, and it became clear that it is suitable as a mask material as a result of the experiment. In them, the most desirable material was the alloy or compound which uses Ti and Ti as a principal component from the business of chemical stability, the

precision of crystal grain, the difficulty of the ability to do of a pinhole, etc.
[0015] so, at least one sort of the alloy which uses Ti, Mg, aluminum, germanium, Pt, Pd and those each, or two sorts or more as a principal component as aforementioned, or its compound constitutes a mask from this invention. That is, Ti, Mg, aluminum and germanium, and Pt, the simple substance metal of Pd, Ti alloy, Mg alloy, aluminum alloy, germanium alloy, Pt alloy, Pd alloy, a Ti-Mg alloy, A Ti-aluminum alloy, a Ti-germanium alloy, a Ti-Pt alloy, a Ti-Pd alloy, A Mg-aluminum alloy, a Mg-germanium alloy, a Mg-Pt alloy, a Mg-Pd alloy, An aluminum-germanium alloy, an aluminum-Pt alloy, an aluminum-Pd alloy, a germanium-Pt alloy, A germanium-Pd alloy, a Ti-Mg-aluminum alloy, a Ti-aluminum-germanium alloy, a Ti-Mg-germanium alloy, At least one sort in a Ti-Mg-Pt alloy, a Ti-aluminum-Pd alloy, a Mg-aluminum-germanium alloy, TiO2, MgF2, aluminum 2O3, TiN, AlN, MgN and GeO2, PdO, etc. constitutes a mask. The convention with "at least one sort" in this case means that the whole mask may be constituted by only one only of sorts of these, and the surface layer which has exposed the mask further by that partial compound or its laminating may be constituted by two or more sorts.
[0016] and the alloy which uses silicon or silicon as a principal component by this invention again -- further -- SiO2 and Si3 N4 etc. -- a compound can also be used as a mask. About the alloy of silicon, considering as combination with Ti, Mg, aforementioned aluminum, aforementioned germanium, etc. is illustrated as a desirable thing. For example, a Ti-Si alloy, a Si-aluminum alloy, an Si-germanium alloy, a Si-Pt alloy, a Si-Pd alloy, a Ti-Si-aluminum alloy, a Ti-Mg-Si alloy, an aluminum-Mg-Si alloy, etc. will be illustrated.
[0017] SiO2 Although the use as a mask is considered until now if it attaches, it is the method of a two-step imprint until now. On the other hand, in this invention, it is used as a new mask by lift off. These masks can be formed with various means, such as vacuum deposition, sputtering and ion plating, and ion beam vacuum evaporationo.
[0018] About the mask of this invention, if it illustrates as a process of micro processing, it will become as drawing 1 . The magnetic thin film (2) whose departure of a micro-processing process is a candidate for processing is formed on suitable substrate materials (1), such as Corning 7059 glass, and forms a resist film (5) with a spin coat method on it as shown in drawing 1 (a). Electron beam lithography of these multilayers is carried out, they are developed, and a desired pattern (6) is formed in a resist film (5) (drawing 1 (b)). Then, vacuum deposition of mask material (7), for example, Ti, is carried out, the lift-off method, i.e., a macromolecule resist, is dissolved, and Ti mask (8) is formed (drawing 1 (d)). Next, it is CO-NH3. A pattern is formed in a magnetic-substance thin film by removing only the part which is not covered with Ti mask of the thin film of the magnetic substance by the reactive-ion-etching method by the mixed-gas plasma (drawing 1 </A> (e)). The magnetic substance (9) which performed micro processing is obtained. In addition, it is CCl4 when you want to remove Ti mask in this process, since the mask of Ti remains while not having been removed by it. Ti mask which remained is removed by the reactive-ion-etching method of the conventional method using the gas plasma (drawing 1 (f)).
[0019] By this invention, the reattachment of a pollutant to the quality of an etching object is accepted by neither of the cases, but etching of a sharp exact configuration of it is attained at them. in addition, the magnetic material which this invention makes the magnetic material as above typical about the target quality of an etching substance, and begins a permalloy and uses transition metals as a principal component about this magnetic material, for example, Fe, nickel, and Co, a Co-Cr alloy, the Sendust alloy, Mo, and rare earth -- it is easy to be the alloy of these elements, and various kinds of things of a compound.
[0020] Moreover, when using the resist film for mask pattern formation, various kinds of things of the organic polymer film by the same exposure phenomenon as usual are used. Of course, you may be direct mask formation. The gas for plasma for etching is CO gas and NH3 as mentioned above, when targetting a magnetic material. Or the case of the nitrogen-containing compound gas of amines is used suitably.
[0021] Hereafter, an example is shown and it explains in more detail.
[0022]

[Example]
The reactive ion etching system was used according to the process shown in example 1 (Ti mask) drawing 1 . On the pattern (6) which formed Fe thin film with a thickness [as a magnetic material thin film (2)] of 450nm by the sputtering method on the Corning 7059 glass substrate (1), and was formed in the surface from the resist film (5) by electron beam lithography and the lift-off method as a sample of etching, Ti was used as a mask material (7), and Ti pad of minute a large number was formed, and it used as a mask (8). It placed on the lower electrode which carries out the seal of approval of the 13.56MHz RF which gave water cooling for the sample, and distance of an RF electrode, it, and the earth electrode that countered was set to 35mm. CO gas and NH3 Supplying gas to a reaction container by the flow rate of 6.3 cc/min and 6.8 cc/min, respectively, it exhausted with the turbo molecular pump and the interior was held to the pressure of 5.7x10-3Torr. They are 3.7 W/cm2 per electrode unit area to the lower electrode holding a sample. The seal of approval of the RF is carried out, and it is CO-NH3. The glow discharge plasma of mixed gas was generated and reactive ion etching was performed. Etching time was set as for 4.0 minutes. The level difference produced between the part covered with Ti pad used as a mask (8) and the part which is not covered was measured with the repeat reflective interferometer after the etching reaction, and the amount of etching per unit time amount was calculated. Moreover, the configuration produced by etching was observed with the electron microscope, and etching was evaluated paying attention to the existence of the smooth nature of a level difference, sharpness and a pollutant, or reattachment material. Fe thin film by which patterning was carried out as the magnetic substance (9) which carried out micro processing was obtained. Consequently, the etching speed to Fe thin film was 90 nm/min. Moreover, by the sharpness which is about 0.1 micrometers, radius of curvature was able to produce the configuration with a depth of 400nm.
[0023] When drawing 3 (a), (b), and (c) consider as Ti mask (a) Fe thin film (b) Co-9.8%Cr thin film (c) It is the electron microscope photograph which illustrated the result of etching of a nickel-20%Fe thin film, and it turns out that the outstanding process tolerance is acquired.
On the same conditions as example 2 (aluminum mask) example 1, vacuum deposition of the aluminum was carried out, aluminum mask was produced by the lift-off method, and reactive ion etching of a nickel-Fe20%Fe alloy was possible. The speed of etching was 120 nm/min and the configuration of etching was good similarly.
On the same conditions as example 3 (Si mask) example 1, vacuum deposition of the Si was carried out, Si mask was produced by the lift-off method, and reactive ion etching of a Co-9.8%Cr alloy was possible. The speed of etching was 140 nm/min and the configuration of etching was good similarly.
On the same conditions as example 3 (germanium mask) example 1, vacuum deposition of the germanium was carried out, germanium mask was produced by the lift-off method, and reactive ion etching of a Co-9.8%Cr alloy was possible. The speed of etching was 140 nm/min and the configuration of etching was good similarly.
[0024]
[Effect of the Invention] CO-NH3 for a magnetic alloy by using the reactive ion etching system of this invention Reactive ion etching using the mixed-gas plasma becomes more effective compared with the case where a conventional-type reactive ion etching system is used. That is, under the same etching conditions, the etching speed to a magnetic alloy increases about 4 times, and contributes to improvement in working efficiency. Moreover, the reattachment of the material which the quality of an etching object is not polluted in an etching process, and was removed by etching can also be made few to the degree which does not become a problem. According to the above operation effects, manufacture of the detailed magnetic head for magnetic recording, a micro transformer, a micro magnetic cell, a magnetic sensor, a magneto-resistive effect element, spin diode and a spin transistor, a spin bulb element, spin bulb MAG memory, a tunnel magneto-resistive effect element, etc. is attained. Moreover, manufacture of PATANDO magnetic-recording data medium of future high density magnetic-recording data medium etc. is attained.

[Translation done.]

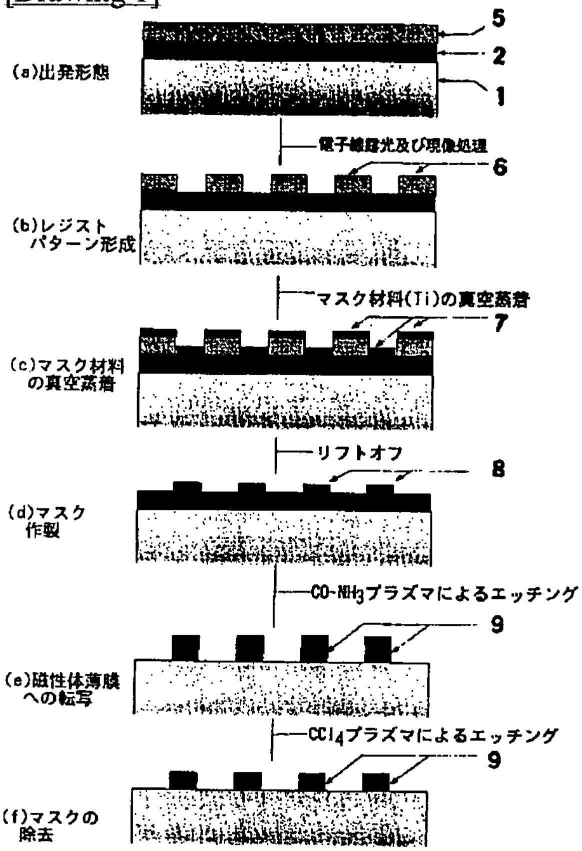
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is process drawing of micro processing of the magnetic material by this invention.
[Drawing 2] It is process drawing of micro processing of the magnetic material by the conventional technology.
[Drawing 3] (a), (b), and (c) are electron microscope photographs which replace respectively the drawing which illustrated the condition after etching.
[Description of Notations]
1 Substrate Material
2 Magnetic Material Thin Film
3 Silicon Oxide (SiO_2) Film
4 Amorphous Carbon Film
5 Resist Film
6 Resist Pattern
7 Mask Material Which Carried Out Vacuum Deposition
8 Mask
9 Magnetic Substance Which Performed Micro Processing

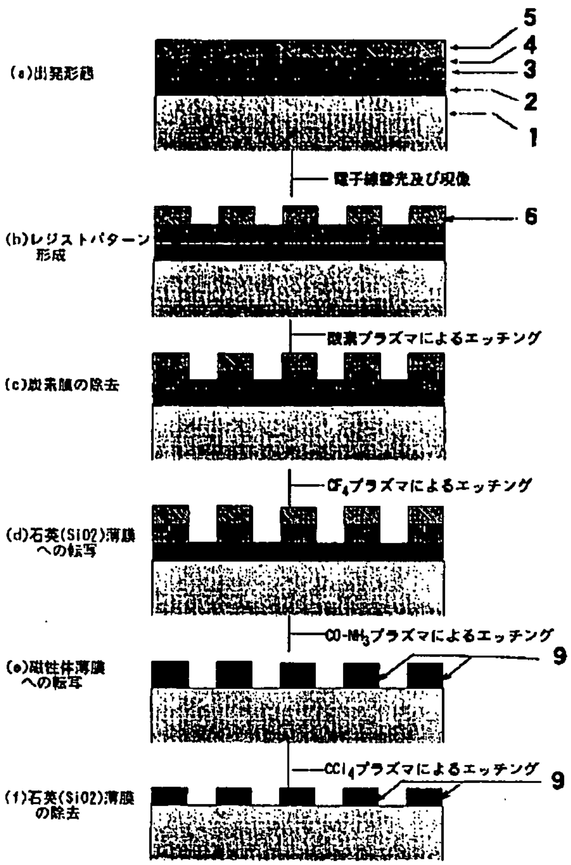
[Translation done.]

DRAWINGS

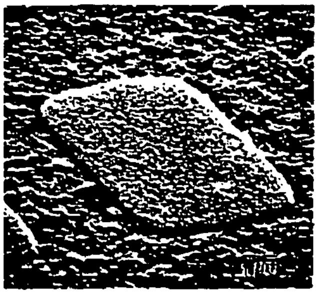
[Drawing 1]



[Drawing 2]

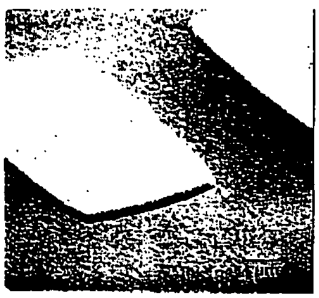

(a)出発形態
5
4
3
2
1
電子線露光及び現像
(b)レジストパターン形成
6
酸素プラズマによるエッチング
(c)炭素膜の除去
CF_4プラズマによるエッチング
(d)石英(SiO_2)薄膜への転写
CO-NH_3プラズマによるエッチング
(e)磁性体薄膜への転写
9
CCl_4プラズマによるエッチング
(f)石英(SiO_2)薄膜の除去
9

[Drawing 3]



(a)

(b)



(c)

[Translation done.]

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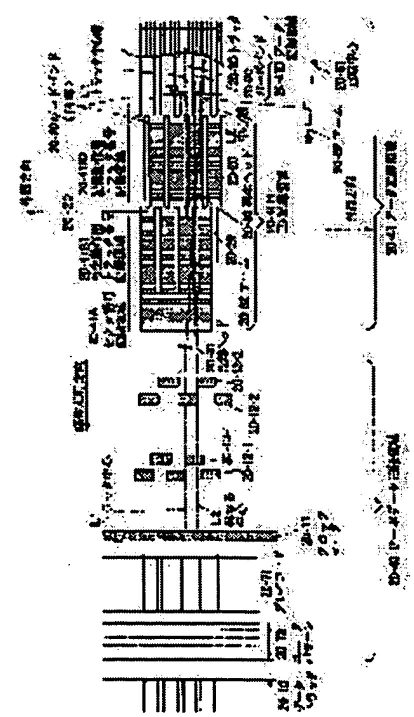
(54) MAGNETIC DISK DEVICE AND PRODUCTION THEREOF

(57)Abstract:
PURPOSE: To increase a recording capacity of a magnetic disk.
CONSTITUTION: Guard bands 20-20 are formed as recessed parts, and tracks 20-10 are formed as projected parts. A clock mark 20-11 is formed not only on the tracks but also continuously between each track. This clock mark 20-11 is formed along a rotational locus of a reproducing head 20-30.



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CLAIMS

[Claim(s)]
[Claim 1] Disk-like data medium by which a magnetic film was formed on a field where information is recorded or reproduced The magnetic head which records or reproduces information to said disk-like data medium An arm which it rotates [arm] where said magnetic head is supported, and moves said magnetic head to a predetermined radius location of said disk-like data medium It is the magnetic disk drive equipped with the above. Said disk-like data medium It has a data storage area and a control signal record section. In said data storage area While a truck is formed the shape of a concentric circle, and in the shape of a spiral, said truck Stamp formation is carried out so that a guard band for a record portion for recording data serving as heights, and classifying said adjoining record portion may serve as a crevice. In said control signal record section While stamp formation of a mark for tracking for carrying out tracking control of said magnetic head, a track number distinguishing mark which specifies said truck, and the clock mark which divides 1 round at equal intervals is carried out by irregularity At least one of them is formed along with a rotation locus of said magnetic head, and it is characterized by controlling record or playback actuation by said magnetic head corresponding to a signal which reproduces said mark for tracking, a track number distinguishing mark, or a clock mark, and is acquired.

[Claim 2] Disk-like data medium by which a magnetic film was formed on a field where information is recorded or reproduced The magnetic head which records or reproduces information to said disk-like data medium It is the magnetic disk drive equipped with the above. Said disk-like data medium It has a data storage area and a control signal record section. In said data storage area While a truck is formed the shape of a concentric circle, and in the shape of a spiral, said truck Stamp formation is carried out so that a guard band which a record portion for recording data serves as heights, and classifies said adjoining record portion may serve as a crevice. In said control signal record section A mark for tracking for carrying out tracking control of said magnetic head at least, A track number distinguishing mark which specifies said truck, and a clock mark which divides 1 round at equal intervals Stamp formation is carried out by irregularity. Said magnetic head Said mark for tracking, It is characterized by measuring variation corresponding to eccentricity of said disk-like data medium, and controlling record or playback actuation of said magnetic head corresponding to the measurement result from a signal which reproduces a track number distinguishing mark or a clock mark, and is acquired.
[Claim 3] The number of groups of said mark for tracking currently recorded on said disk-like data medium, a track number distinguishing mark, and a clock mark is a magnetic disk drive according to claim 1 or 2 characterized by being 1000 or less per round.
[Claim 4] A rate of occupying to 1 round of said control signal record section of said disk-like data medium is a magnetic disk drive according to claim 1, 2, or 3 characterized by being 40% or less.
[Claim 5] Said disk-like data medium is a magnetic disk drive according to claim 1 to 4 characterized by being formed in a substrate of resin or glass.
[Claim 6] Said magnetic head is a magnetic disk drive according to claim 1 to 5 characterized by separating into a recording head which records data, and the reproducing head to reproduce.

[Claim 7] It is the magnetic disk drive according to claim 6 with which said mark for tracking and track number distinguishing mark have the 1st mark used at the time of record, and the 2nd mark used at the time of playback, and said 2nd mark is characterized by thing of said truck for which it is mostly arranged along a center and said 1st mark is arranged mostly in a location of said truck where only a predetermined distance shifted to radial from a center.
[Claim 8] Said mark for tracking and said track number distinguishing mark are a magnetic disk drive according to claim 7 characterized by being constituted by two or more marks which have the same function.
[Claim 9] Variation corresponding to eccentricity of said disk-like data medium is a magnetic disk drive according to claim 2 characterized by being location variation measured from said mark for tracking, or a track number distinguishing mark, or the time amount variation measured from said clock mark.
[Claim 10] A magnetic disk drive according to claim 9 characterized by calculating an eccentric controlled variable which amends a location gap which originates in eccentricity from said truck of said magnetic head from a signal which reproduces said mark for tracking, a track number distinguishing mark, or a clock mark, and is acquired.
[Claim 11] A magnetic disk drive according to claim 10 which memorizes said eccentric controlled variable calculated and obtained, and is characterized by reading said memorized eccentric controlled variable, adding to a tracking control signal, and carrying out tracking control of said magnetic head.
[Claim 12] A magnetic disk drive according to claim 9 characterized by generating a clock signal synchronizing with said clock mark, memorizing time amount variation measured from said clock mark, and amending a time-axis of said clock signal corresponding to said memorized time amount variation.
[Claim 13] A signal which reproduces said track number distinguishing mark and is acquired is a magnetic disk drive according to claim 1 to 12 characterized by carrying out a CRC operation at coincidence in time amount by which Viterbi decoding is carried out.
[Claim 14] A magnetic disk drive according to claim 1 to 13 characterized by generating a clock signal from a signal which reproduces said clock mark and is acquired, delaying record data corresponding to said clock signal, and recording said delayed record data on said disk-like data medium.
[Claim 15] A magnetic disk drive according to claim 1 to 14 characterized by judging magnitude of the amount of relative location gaps of said magnetic head and truck which were measured from said mark for tracking, and controlling record actuation to said disk-like data medium corresponding to the judgment result.
[Claim 16] Said disk-like data medium, the magnetic head, and an arm are a magnetic disk drive according to claim 1 to 15 which is held in the interior of a sealed case which consists of a top case and a bottom case, and is characterized by forming only a spiracle for pressure regulation which adjusts a difference of an atmospheric pressure inside said case and an external atmospheric pressure which were sealed at the plane section of said top case and a bottom case.
[Claim 17] Said disk-like data medium is a magnetic disk drive according to claim 1 to 16 with which the diameter is characterized by being about 2.5 inches.
[Claim 18] Said disk-like data medium is a magnetic disk drive according to claim 1 to 16 with which the diameter is characterized by being about 1.8 inches.
[Claim 19] Said disk-like data medium is a magnetic disk drive given in claim claim 1 to which the diameter is characterized by being about 1.3 inches thru/or either of 16.
[Claim 20] Disk-like data medium by which a magnetic film was formed on a field where information is recorded or reproduced The magnetic head which records or reproduces information to said disk-like data medium It is the manufacture method of a magnetic disk drive equipped with the above, and a data storage area and a control signal record section are formed in said disk-like data medium. In said data storage area So that a guard band for classifying said record portion which a record portion the shape of a concentric circle and for recording data for said truck while forming a truck spirally serves as heights, and adjoins may serve as a crevice A mark for tracking for carrying out stamp formation and carrying out tracking control of said magnetic head to said control signal record section at least, A track number distinguishing mark which specifies said truck, and a clock mark which divides 1 round at equal

intervals Stamp formation is carried out with irregularity and it is characterized by assembling said disk-like data medium to a case with said magnetic head, after said mark for tracking, a track number distinguishing mark, and a clock mark are formed and recorded.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention is used for the hard disk drive unit in a computer system, and relates to a suitable magnetic disk drive and its manufacture method.
[0002]
[Description of the Prior Art] In the computer system, a hard disk drive unit is used and it is made as [access / a high speed] to the program or data recorded there. In this hard disk drive unit, a magnetic film is formed in both sides of a magnetic disk, and it is made as [carry out / by the premature start type magnetic head / at that magnetic layer / record playback of the data]. Since the device section which drives the magnetic head, and the mechanical component which drives a magnetic disk are beforehand included in the interior of a case, it can record data on high density comparatively.
[0003]
[Problem(s) to be Solved by the Invention] However, the magnetic film was formed over the whole surface of the surface, and the magnetic disk in the conventional magnetic disk drive had the technical problem which must prepare the guard band between trucks by comparatively large width of face, in order to control the cross talk from an adjoining truck. Consequently, a track pitch could not be narrowed but it was set to one of the failures of realizing the equipment which has small and big storage capacity.
[0004] If this is included in a case after recording beforehand the clock signal which constitutes an encoder on a magnetic disk further again as opposed to a magnetic disk, the installation error at the time of assembly (eccentricity) will occur, and it will become difficult to carry out record playback of the data in an exact location. Then, after building a magnetic disk into a case conventionally, he was trying to record the signal which forms an encoder. Consequently, completing equipment took time amount and the technical problem used as the cost high occurred.
[0005] While this invention is made in view of such a condition and having the storage capacity of high density more, the magnetic disk drive and its manufacture method of low cost are realized.
[0006]
[Means for Solving the Problem] Disk-like data medium by which a magnetic film was formed on a field where, as for a magnetic disk drive according to claim 1, information is recorded or reproduced (magnetic disk), The magnetic head which records or reproduces information to disk-like data medium (a recording head 20-31, reproducing head 20-30), In a magnetic disk drive which has an arm (20-62) which it rotates [arm] where the magnetic head is supported, and moves the magnetic head to a predetermined radius location of disk-like data medium disk-like data medium It has a data storage area (data storage area 20-41D) and a control signal record section (the servo data storage area 20-40, ID record section 20-41H). In a data storage area While a truck is formed the shape of a concentric circle, and in the shape of a spiral, a truck So that a guard band (20-20) for a record portion for recording data serving as heights, and classifying an adjoining record portion may serve as a crevice A mark for tracking for stamp formation being carried out and carrying out tracking control of the magnetic head to

a control signal record section (wobble DOMAKU 20-12, 20-13), A track number distinguishing mark which specifies a truck (Gray code 20-71, a track number 20-41b1, 20-41b2), While stamp formation of the clock mark (20-11) which divides 1 round at equal intervals is carried out by irregularity, and at least one of them It is formed along with a rotation locus (21-21) of the magnetic head, and is characterized by controlling record or playback actuation by the magnetic head corresponding to a signal which reproduces a mark for tracking, a track number distinguishing mark, or a clock mark, and is acquired.
[0007] Disk-like data medium by which a magnetic film was formed on a field where, as for a magnetic disk drive according to claim 2, information is recorded or reproduced (magnetic-disk 50-1A, 50-1B), In a magnetic disk drive equipped with the magnetic head (50-3A, 50-3B) which records or reproduces information to disk-like data medium disk-like data medium It has a data storage area (20-41D) and a control signal record section (the servo data storage area 20-40, ID record section 20-41H). In a data storage area While a truck (20-10) is formed the shape of a concentric circle, and in the shape of a spiral, a truck So that a guard band (20-20) which a record portion (20-10) for recording data serves as heights, and classifies an adjoining record portion may serve as a crevice A mark for tracking for stamp formation being carried out and carrying out tracking control of the magnetic head to a control signal record section at least (wobble DOMAKU 20-12, 20-13), A track number distinguishing mark which specifies a truck (Gray code 20-71, a track number 20-41b1, 20-41b2), And stamp formation of the clock mark (20-11) which divides 1 round at equal intervals is carried out by irregularity. It is characterized by measuring variation corresponding to eccentricity of disk-like data medium, and controlling record or playback actuation of the magnetic head corresponding to the measurement result from a signal with which the magnetic head reproduces a mark for tracking, a track number distinguishing mark, or a clock mark, and is obtained.
[0008] The number of groups of a mark for tracking currently recorded on this disk-like data medium, a track number distinguishing mark, and a clock mark can be made less than into per round (for example, 1000 pieces). Moreover, a rate of occupying to 1 round of a control signal record section of disk-like data medium can be made into 40% or less. Furthermore, this disk-like data medium can be formed in a substrate of resin or glass.
[0009] The magnetic head is separable into a recording head which records data, and the reproducing head to reproduce.
[0010] the 1st mark 20-41b2 by which a mark for tracking and a track number distinguishing mark are used at the time of record, and the 2nd mark 20-41b1 used at the time of playback -- constituting -- the 2nd mark -- a truck -- it can arrange along a center mostly and the 1st mark can be mostly arranged from a center in a location of a truck where only a predetermined distance shifted to radial. Moreover, two or more marks which have the same function can constitute this mark for tracking, and a track number distinguishing mark.
[0011] Furthermore, location variation measured from a mark for tracking or a track number distinguishing mark or time amount variation measured from a clock mark is detectable as variation corresponding to eccentricity of disk-like data medium.
[0012] Furthermore, an eccentric controlled variable which amends a location gap which originates in eccentricity from a truck of the magnetic head from a signal which reproduces a mark for tracking, a track number distinguishing mark, or a clock mark, and is acquired can be calculated. Moreover, an eccentric controlled variable calculated and obtained is memorized, a memorized eccentric controlled variable can be read, it can add to a tracking control signal, and tracking control of the magnetic head can be carried out. Or a clock signal is generated synchronizing with a clock mark, time amount variation measured from a clock mark is memorized, and a time-axis of a clock signal can be amended again corresponding to memorized time amount variation.
[0013] Furthermore, in time amount which is carrying out Viterbi decoding of the signal which reproduces a track number distinguishing mark and is acquired, a CRC operation can be carried out at coincidence.
[0014] Or a clock signal is generated from a signal which reproduces a clock mark by the reproducing head and is acquired, and corresponding to a clock signal, only a part corresponding to distance of the

reproducing head and a recording head or a part which amends a nonlinear bit shift is delayed in record data, and can record delayed record data on disk-like data medium.
[0015] Furthermore, a location gap measured from a mark for tracking is judged, and record actuation to disk-like data medium can be controlled corresponding to the judgment result.
[0016] Only a spiracle (100-34) can be formed in a case (100-1,100-31) which holds disk-like data medium and the magnetic head.
[0017] This disk-like data medium can make that diameter 2.5 inches, 1.8 inches, or 1.3 inches.
[0018] A manufacture method of a magnetic disk drive according to claim 20 Disk-like data medium by which a magnetic film was formed on a field where information is recorded or reproduced (magnetic disk 100-23), In a manufacture method of a magnetic disk drive of having the magnetic head (20-30, 20-31) which records or reproduces information to disk-like data medium A data storage area (20-41) and a control signal record section (servo data storage area 20-40) are formed in disk-like data medium. In a data storage area While forming a truck the shape of a concentric circle, and in the shape of a spiral, a truck So that a guard band (20-20) for a record portion (20-10) for recording data serving as heights, and classifying an adjoining record portion may serve as a crevice A mark for tracking for carrying out stamp formation and carrying out tracking control of the magnetic head to a control signal record section at least (wobble DOMAKU 20-12, 20-13), A track number distinguishing mark which specifies a truck (Gray code 20-71), And stamp formation of the clock mark (20-11) which divides 1 round at equal intervals is carried out with irregularity. It is characterized by assembling disk-like data medium to a case (100-1,100-31) with the magnetic head, after a mark for tracking, a track number distinguishing mark, and a clock mark are formed and recorded.
[0019]
[Function] In the magnetic disk drive according to claim 1, the guard band is formed as a physical crevice to the record portion which records the data of a truck. In order for a possibility that data may be reproduced from there to decrease and to mitigate a cross talk, it becomes unnecessary therefore, to enlarge width of face of a guard band. Consequently, it becomes possible to narrow a guard band and to enlarge storage capacity.
[0020] Furthermore, even if it uses opto-electronics, it becomes possible to arrange these marks in a very exact location and it narrows a track pitch in order to carry out stamp formation of the mark for tracking, a track number distinguishing mark, or the clock mark with irregularity along with the rotation locus of the magnetic head for example, it becomes possible to carry out record playback of the data correctly.
[0021] Moreover, in a magnetic disk drive according to claim 2, the eccentricity of disk-like data medium is measured and record playback actuation is controlled corresponding to this. Therefore, it sets, when the mark for tracking, a track number distinguishing mark, or a clock mark builds disk-like data medium into a case in the condition of having been formed beforehand, and even if it originates in the installation error at the time of inclusion and eccentricity occurs, it becomes possible to make the magnetic head access correctly to a truck.
[0022] After carrying out stamp formation with irregularity, he is trying to assemble the mark for tracking, a track number distinguishing mark, and a clock mark to a case in the manufacture method of a magnetic disk drive according to claim 20 with the magnetic head. Therefore, processing which records an encoder becomes unnecessary after assembly, and equipment can be completed in a short time. Consequently, it becomes possible to also reduce cost.
[0023]
[Example] Drawing 1 shows the configuration of the whole magnetic disk drive of this invention. The motor section 10-1 rotates the magnetic-disk section 10-2 at the rate of predetermined. The recording head section 10-3 and the reproducing-head section 10-4 are attached in the arm section 10-5, and it is made as [move / by rotating a predetermined shaft as a center / to the predetermined radius location of the magnetic-disk section 10-2 / the recording head section 10-3 and the reproducing-head section 10-4]. These motor sections 10-1, the magnetic-disk section 10-2, the recording head section 10-3, the reproducing-head section 10-4, and the arm section 10-5 are held in the case section 10-10.
[0024] Various marks are beforehand formed in the magnetic-disk section 10-2, the clock signal

generation section 10-6 generates a clock signal from the signal with which the reproducing-head section 10-4 reproduces and outputs the mark, and it outputs to the tracking servo section 10-7 and the playback section 10-8. The tracking servo section 10-7 generates a tracking error signal from the signal which the reproducing-head section 10-4 outputs with reference to the clock signal supplied from the clock signal generation section 10-6, and drives the arm section 10-5 corresponding to this. Thereby, tracking control of the recording head section 10-3 and the reproducing-head section 10-4 is carried out to the predetermined radius location of the magnetic-disk section 10-2.

[0025] The Records Department 10-9 modulates the record signal supplied from the circuit which is not illustrated, and makes it record on the magnetic-disk section 10-2 through the recording head section 10-3. From the signal with which the reproducing-head section 10-4 reproduces and outputs the data currently recorded on the magnetic-disk section 10-2, the playback section 10-8 carries out recovery processing of the record data, and outputs it to the circuit which is not illustrated.

[0026] The monitor of the tracking error signal is carried out, a big shock etc. joins equipment again, the tracking servo section 10-7 controls the Records Department 10-9, when the recording head section 10-3 secedes from a truck, and it stops record actuation.

[0027] Although the above is the configuration and actuation of the whole magnetic disk drive of this invention, in order to migrate to the many fields of this magnetic disk drive, for every point, the point of this invention divides those contents and is explained.

[0028] The point about the magnetic-disk section 10-2 is explained to the beginning with reference to drawing 2 thru/or drawing 16 . Here, explanation about the rate of the shape of the format of a magnetic disk and a plan type, a cross-section configuration, a magnetization method, surface treatment, and a servo data area etc. is given.

[0029] Next, explanation of the point about the recording head section 10-3 and the reproducing-head section 10-4 is given with reference to drawing 17 and drawing 18 . Here, the gap and cross-section structure of the magnetic head are explained.

[0030] The point about the arm section 10-5 is explained to the degree with reference to drawing 19 and drawing 20 . Here, the structure of an arm is explained.

[0031] Moreover, next it is the arm section 10-5, with reference to drawing 21 thru/or drawing 33 , explanation of the point about the clock signal generation section 10-6 is given. Here, explanation of clock signal generation and the method of the eccentric measurement which is needed for time-axis amendment of this clock are explained.

[0032] Next, explanation of the point about the tracking servo section 10-7 is given with reference to drawing 34 thru/or drawing 43 . Here, actuation of a tracking servo and the number of servo data storage areas required for a tracking servo are explained. Moreover, how to judge an off-track using a tracking error signal is explained.

[0033] Furthermore, with reference to drawing 44 thru/or drawing 50 , explanation of the point about the playback section 10-8 and explanation of the point concerning the Records Department 10-9 with reference to drawing 51 thru/or drawing 58 are given. Here, playback of data and record are explained.

[0034] And explanation of the point about the case section 10-10 is given at the last with reference to drawing 59 thru/or drawing 64 . Here, the case which holds the magnetic head, a magnetic disk, etc. is explained.

[0035] The configuration shown in this drawing 1 is decomposed if needed, and only a required element is extracted suitably and reconfigurated so that explanation for which it was suitable for every point may be given in explanation of each [these] point. Therefore, the technical element used in explanation of each point does not necessarily support 1 to 1 with the partition condition of the element in this drawing 1 . This is because only a required technical element is recombined organically and he is trying to express it, in order to explain each technical point.

[0036] First, the point of the magnetic-disk section 10-2 of drawing 1 is explained.

[0037] As for the magnetic disk used for this magnetic disk drive, the 1 round is classified into 60 sectors, and each sector is constituted by 14 segments. Therefore, it becomes 840 segments 1 round. Each segment is classified into a servo data storage area and a data storage area (21-2 and 21-3 of 20-40,

20-41, or drawing 6 of drawing 2). Gray code 20-71, the clock mark 20-11 and wobble DOMAKU 20-12, and 20-13 are formed in each servo data storage area. Moreover, the unique pattern 20-72 is further added to the segment of the head of each sector. However, in one sector in 60 sector, it replaces with a unique pattern and the home index 20-73 which has a function as a PG is recorded.
[0038] Drawing 3 shows the example of a configuration of the servo data storage area 20-40 in which the unique pattern 20-72 is formed. The clock mark 20-11 is arranged at the degree, and wobble DOMAKU 20-12 and 20-13 are further arranged for Gray code 20-71 after the at the degree of the unique pattern 20-72.
[0039] Drawing 4 is replaced with the unique pattern 20-72, and the example by which the home index 20-73 is arranged is shown. Moreover, drawing 5 shows the example in which neither the unique pattern 20-72 nor the home index 20-73 is formed.
[0040] Drawing 2 shows the example of a configuration of the servo data storage area 20-40 in which the unique pattern 20-72 is formed, and the data storage area 20-41 just behind that.
[0041] It sets in this example, and the unique pattern 20-72, Gray code 20-71 (the absolute address 0 which specifies a truck thru/or 2800 (track number) are expressed), the clock mark 20-11, wobble DOMAKU 20-12 (20-12-1, 20-12-2), and 20-13 (20-13-1, 20-13-2) are formed and recorded on the servo data storage area 20-40.
[0042] When setting width of face (width of face of the inside of drawing, and a longitudinal direction) of the direction of a truck of the clock mark 20-11 to 1, width of face of 20 and the unique pattern 20-72 is set to 16 for the width of face of Gray code 20-71.
[0043] The clock mark 20-11 is a mark for generating the clock used as the criteria of record playback, and the reproducing head 20-30 outputs a timing signal corresponding to that edge, when this clock mark 20-11 is reproduced. As shown in drawing 2 , the clock mark 20-11 is not only formed in data tracks 20-10, but is formed in the field between a truck 20-10 and a truck 20-10 (between trucks). That is, the clock mark 20-11 follows a radial, and is formed in radial [of a disk] (refer to drawing 6).
[0044] Only a predetermined distance is estranged also in the direction of a truck, and wobble DOMAKU 20-12-1 and 20-13-1 are formed in it while they are arranged so that it may shift to an inner circumference and periphery side on both sides of the center line L1 of a truck 20-10. When the reproducing head 20-30 reproduces this wobble DOMAKU 20-12-1 and 20-13-1, a location pulse is outputted corresponding to that edge location. By applying a tracking servo so that the level of this location pulse may become equal, the reproducing head 20-30 can be arranged on the center line L1 of a truck 20-10.
[0045] As wobble DOMAKU, further 20-12-2 and 20-13-2 are prepared. About this, it mentions later.
[0046] This wobble DOMAKU 20-12-1, 20-13-1, 20-12-2, and 20-13-2 are made into the same width of face (truck lay length) as the clock mark 20-11, and it is referred to as 0.6 micrometers by the most inner circumference, and they are set to 1.2 micrometers by the outermost periphery.
[0047] The data by which ID record section 20-41H are formed in the head of a data storage area 20-41, and record playback is originally carried out is made as [record / on field 20-41D following these ID record section 20-41H].
[0048] ID record section 20-41H are classified into sector number record section 20-41A and track number record section 20-41B (20-41B1, 20-41 B-2). Among these, like the clock mark 20-11 mentioned above, from the first, also between trucks, a truck 20-10 follows radial and is formed by sector number record section 20-41A at least. Sector number 20-41a which specifies a sector is recorded on this sector number record section 20-41A, and track number 20-41b which specifies a truck is recorded on track number record section 20-41B. The reproducing head 20-30 outputs a pulse train by reproducing these ID record section 20-41H.
[0049] Let a total of the 40-bit data which consists of a sector number of 8 bits, and two track numbers of 16 bits be data (ID data) recorded on ID record section 20-41H.
[0050] PR (partial response) (0 -1, 1) modulation is carried out, and these ID data is recorded on ID record section 20-41H.
[0051] In the case of a CAV disk, the sector number is the same in the truck by the side of inner

circumference, and the truck by the side of a periphery. Then, this sector number is continuously recorded also on the field between not a truck 20-10 upper-bed loan but trucks.
[0052] Moreover, track number record section 20-41B is classified into the track number record section 20-41B1 for playback actuation, and track number record section 20-41 B-2 for record actuation.
[0053] The track number record section 20-41B1 for playback actuation is formed so that the center (crosswise center) may be located on the center line L1 of a truck 20-10, but track number record-section 20-41 B-2 for record actuation is formed so that the center line L2 may become the location (offset location) which only the center line L1 and the distance d of a truck 20-10 left in the direction (disk radial) perpendicular to a truck 20-10. And the same track number 20-41b1 and 20-41b2 are recorded on this track number record section 20-41B1 for playback actuation, and track number record section 20-41 B-2 for record actuation.
[0054] In addition, you may make it record two or more respectively same track numbers on each field 20-41B1 and 20-41 B-2. It becomes possible to read a track number thereby more certainly.
[0055] The offset value d of track number record section 20-41 B-2 for record actuation is made into such a small value that it goes to an inner circumference side, and let it be such a large value that it goes to a periphery side.
[0056] Moreover, as shown in drawing 2 , the center line L1 of a truck 20-10 (sector number record section 20-41A and track number record section 20-41B1 for playback actuation) is received. Form wobble DOMAKU 20-12-1 for positioning the reproducing head 20-30, and 20-13-1, and also Wobble DOMAKU 20-12-2 for positioning in the case of tracing the center line L2 of track number record section 20-41 B-2 for record actuation by the reproducing head 20-30 and 20-13-2 are formed in the servo data storage area 20-40.
[0057] Therefore, the reproducing head 20-30 can be made to scan along with the center line L1 of a truck 20-10 by carrying out tracking control of the reproducing head 20-30 on the basis of wobble DOMAKU 20-12-1 and 20-13-1 at the time of a playback mode.
[0058] On the other hand, the reproducing head 20-30 can be made to scan along with the center line L2 of track number record section 20-41 B-2 for record actuation by performing tracking control corresponding to the tracking error signal which reproduces wobble DOMAKU 20-12-2 and 20-13-2 by the reproducing head 20-30, and is acquired at the time of a recording mode. At this time, a recording head 20-31 runs along with the center line L1 of a truck 20-10.
[0059] In the above example In addition, usual wobble DOMAKU 20-12-1, 20-13-1, offset wobble DOMAKU 20-12-2, 20-13-2, sector number record section 20-41A, Although arranged in order of the track number record section 20-41B1 for playback actuation, track number record section 20-41 B-2 for record actuation, and field 20-41D For example, usual wobble DOMAKU 20-12-1, 20-13-1, sector number record section 20-41A, The 1st group of the track number record section 20-41B1 for playback actuation and field 20-41D is followed. Repeat arrangement of the 2nd group of offset wobble DOMAKU 20-12-2, 20-13-2, offset track number record section 20-41 B-2 for record actuation, and field 20-41D can be carried out.
[0060] Moreover, the track number record section 20-41B1, the track number 20-41b1 recorded on 20-41 B-2, and 20-41b2 are used in a record reversion system, and although Gray code 20-71 carries out correspondence to this, it is not used in servo system and both is not the same. However, since it is used for the control for checking the truck which records or reproduces all, the servo data storage area 20-40 and ID record section 20-41H can be recognized to be control signal record sections.
[0061] Thus, since the field which records a sector number or a track number is formed beforehand and the sector number or the track number was recorded there, a sector number or a track number is certainly reproducible irrespective of the positioning condition of the reproducing head.
[0062] In this invention Namely, others [data / (pattern) /, such as the unique pattern 20-72 of the servo data storage area 20-40, the home index 20-73, Gray code 20-71, the clock mark 20-11, wobble DOMAKU 20-12, and 20-13, / servo], A truck is formed of it and recorded on sector number 20-41a of ID record section 20-41H, a track number 20-41b1, 20-41b2, and a pan by irregularity (stamp).
[0063] For example, the guard band 20-20 is formed so that only 200nm may become low from data

tracks 20-10 (as a crevice). That is, the truck is formed discrete.
[0064] In addition, the structure which forms each field with a stamp is indicated by Japanese Patent Application No. No. 71731 [four to] in this way. If the principle is explained briefly, such a magnetic disk can apply and manufacture the technology in an optical disk. That is, glass original recording is prepared and the surface is coated with a photoresist. And a laser beam is irradiated only at the portion which forms the crevice of this photoresist. A photoresist is developed and an exposure portion is removed, after irradiating a laser beam. Thus, it carries out based on the formed original recording, La Stampa is created, and a lot of replicas are manufactured from this La Stampa. The level difference created to original recording is imprinted by this replica. This level difference can complete a magnetic disk by forming a magnetic film in the imprinted surface.
[0065] In drawing 2 , the field which the field which performs and shows hatching in drawing is magnetized by N pole corresponding to the logic 1 of ID data, and has not performed hatching is a field magnetized by the south pole corresponding to logic 0.
[0066] A truck rotates the shape of a concentric circle, and this magnetic disk formed spirally by the constant angular velocity (zone bit recording).
[0067] Moreover, a truck is formed in between one half of the locations of a location to the outermost periphery of a disk radius (i.e., one half by the side of the periphery of a radius of ranges).
[0068] The diameter of a disk is made into 2.5 inches, 1.8 inches, or 1.3 inches. 5.2 micrometers and the width of recording track are set to 3.6 micrometers, and a guard band is set to 1.6 micrometers for a track pitch.
[0069] Thus, capacity of 200MB can be realized by both sides of the disk with a diameter of 2.5 inches of one sheet, and capacity of 100MB can be realized by both sides of the disk with a diameter of 1.8 inches of one sheet, respectively.
[0070] Drawing 6 indicates the example of a configuration of the device in which the magnetic head 21-13 which records or reproduces data to the data area is driven to be the magnetic disk of this invention.
[0071] In the magnetic disk 21-1 of this invention, as explained with reference to drawing 2 , each segment is classified into the data storage area 21-3 (20-41 of drawing 2), and the servo data storage area 21-2 (20-40 of drawing 2). And the servo data storage area 21-2 and data storage area 21-3 are formed along with the migration locus 21-21 which the magnetic head 21-13 moves.
[0072] In this equipment, the magnetic head 21-13 is attached at the tip of the arm 21-11 whose rotation is enabled through the supporting point 21-12. The supporting point 21-12 is pinched, with the installation location of the magnetic head 21-13 of an arm 21-11, the voice coil 21-15 is attached in the opposite side, and the magnet 21-14 is arranged at the voice coil 21-15 bottom. Therefore, if predetermined drive current is supplied to a voice coil 21-15 by the drive circuit 21-16, electromagnetic force acts on the voice coil 21-15 arranged all over the magnetic-flux way which a magnet 21-14 generates, and it is made as [rotate / the supporting point 21-12 / an arm 21-11 / as a center]. At this time, the magnetic head 21-13 will move in a locus 21-21 top. This locus 21-21 serves as a circle which passes along the center 21-4 of a magnetic disk 21-1 focusing on the supporting point 21-12.
[0073] In addition, in this drawing, although it is made the straight arm, a vent arm can also be used.
[0074] Drawing 7 shows the more detailed example of a configuration of the field of the dedication for recording the servo signal in the servo data storage area 21-2.
[0075] In the example of drawing 7 , it is formed as a pattern of the shape of an abbreviation rectangle formed of the curve in alignment with the migration locus 21-21 when the servo mark SM (clock mark, wobble DOMAKU, Gray code, unique pattern, and home index) rotates the arm 21-11 of the magnetic head 21-13, and the curve along the truck of a magnetic disk 21-1. Moreover, all the fields formed with a stamp besides the data area of ID record section 20-41H in drawing 2 are formed along with the migration locus of the magnetic head 21-13.
[0076] In addition, since the servo mark SM is greatly exaggerated in drawing and is shown in it to the radius of a truck and a locus 21-21, each side of the servo mark SM is expressed with the curve, but in fact, since it is very small compared with the radius of a truck or the migration locus 21-21, substantially, almost will be surrounded in a straight line by length of one side of this servo mark SM.

[0077] Time interval nature -- it can set at the time of seek operation -- does not collapse, therefore the lock of the PLL circuit for clock generation (50-30 of drawing 21) seems thus, not to separate from them at the time of seek operation, if the servo mark SM formed with a stamp and other marks are arranged along with the migration locus 21-21. Moreover, if the magnetic head 21-13 without a vent angle (a vent angle is 0 times and the magnetic gap line 21-41 parallel to the magnetic gap of the magnetic head 21-13 becomes a truck and a perpendicular) performs record playback, since a magnetic gap will become always perpendicular to a truck, an azimuth loss does not occur.
[0078] Drawing 8 shows the cross-section configuration of the magnetic disk 21-1 of the above configurations. Drawing 8 (a) expresses the cross section of a direction perpendicular to a truck, and this drawing (b) shows the cross section which met in the direction of a truck. As shown in these drawings, the magnetic film 21-62 is formed in the field where the level difference is formed in the surface, and the level difference is formed in the substrate 21-61 which consists of synthetic resin, glass, aluminum, etc. And a guard band (GB) is constituted by the portion with a low level difference (crevice), and a truck (record portion) is constituted by the high portion (heights).
[0079] As each truck is shown in drawing 8 (b), the data storage area 21-3 is made still flat. On the other hand, in the servo data storage area 21-2, only the portion which records the servo mark SM, the clock mark CM, etc. has projected (considering as the same height as the data-logging section), and the non-record section which does not record a servo signal is formed lower (as a crevice). As mentioned above, the disk which has such irregularity can apply and manufacture optical disk technology.
[0080] Since the servo data storage area and ID record section were formed along with the migration locus in case the magnetic head moves to an inner circumference side direction or a periphery side direction according to this magnetic disk, time interval nature -- it can set at the time of seek operation -- can be held, and the lock end of the PLL circuit for clock generation can be controlled. Moreover, it becomes possible to control an azimuth loss.
[0081] Next, the magnetization method of the magnetic disk which has irregularity is explained in this way. The servo data storage area 21-2 will be established in 1 round at 840 equiangular distances, and pattern (stamp) formation of the heights 22-13 of the rectangle by which length L to which the width of face W of a direction perpendicular to a truck met there in about 5 micrometers and the transit direction of a disk as shown in drawing 9 was set to 0.7 thru/or about 2.9 micrometers will be carried out corresponding to the signal.
[0082] To such a magnetic disk 22-1, as arrow heads m1 and m2 show drawing 9 , the sense of magnetization is made into the reverse sense in heights 22-13 and a crevice 22-14, and a positioning signal is written in (wobble DOMAKU, a clock mark, track number, etc.).
[0083] Rotation transit is made to carry out in the direction which shows a magnetic disk 22-1 by the arrow head a in this example, to the above-mentioned magnetic disk 22-1 (21-1 of drawing 6), as first shown in drawing 10 (a). Impressing the 1st direct current to the magnetic head 22-2 (magnetic head of a manufacturing installation), this magnetic head 22-2 is moved to radial [on a magnetic disk 22-1] by the track pitch, and the magnetic layer 22-12 of the heights 22-13 of a magnetic disk 22-1 and a crevice 22-14 is once altogether magnetized in the same direction.
[0084] And as shown in drawing 10 (b) after that, the 1st direct current is reversed polarity. While a current value impresses the 2nd small direct current to the magnetic head 22-2 compared with the 1st direct current Moved this magnetic head 22-2 by the track pitch like radial [of a magnetic disk 22-1], it was made to scan, only the magnetic layer 22-12 of the heights 22-13 of a magnetic disk 22-1 was magnetized to the reverse sense, and the positioning signal was written in.
[0085] As the magnetic head 22-2, the gap length g0 of magnetic gap G used the thing of a thing with the center tap of 56 turns of 0.4 micrometers, the width of recording track of 100 micrometers, and a coil coil (28+28). And this magnetic head 22-2 was surfaced on the magnetic disk 22-1 by making relative velocity with a magnetic disk 22-1 into 6 m/s. The flying height d at this time was 0.13 micrometers.
[0086] Thus, since a positioning signal can be written in by the one magnetic head, exchange of an arm head can be omitted and improvement in the productivity of a disk can be aimed at.
[0087] Drawing 11 expresses the more detailed cross-section structure of the magnetic disk magnetized

by doing in this way. As shown in this drawing, the level difference (crevice) of 200nm is formed in the substrate 23-11 which consists of plastics, glass, or aluminum. When this substrate 23-11 consists of glass, that thickness is set to 0.65mm, and that thickness is set to 1.2mm when it consists of plastics. A magnetic layer 23-12 is formed in both sides of a substrate 23-11.
[0088] As this magnetic layer 23-12, particle layer 23-12A by which 0.5 or more grain density [100 or less] per micrometer was preferably made about ten pieces is first formed on the substrate 23-11. Particle (spherical silica) 23-12a set to this particle layer 23-12A from SiO2 is distributed over the above-mentioned density.
[0089] When glass or aluminum constitutes a substrate 23-11, it is possible to secure rigidity comparatively. However, when plastics is used, sufficient rigidity cannot necessarily be secured, and also in the field of endurance, it is inferior to glass or aluminum. Furthermore, since the irregularity on the surface of a substrate is coarse, it becomes difficult to carry out contiguity arrangement of the magnetic head in the range which does not contact a magnetic layer 23-12. Then, concavo-convex detailed-ization is attained by forming particle layer 23-12A like this magnetic disk. This is because surface irregularity is determined with the density and particle size of particle 23-12a.
[0090] This particle (spherical silica) 23-12a can be made to adhere on a substrate 23-11 by the dipping method. 50nm or less of pitch diameters of a particle is preferably set to 8 thru/or 10nm. When the mean particle diameter was set to 8nm, particle size distribution was set to 4.3nm with standard deviation. It distributed so that it might become isopropyl alcohol with 0.01 % of the weight of concentration, and the spherical silica pulled up this, and applied it to the surface of a substrate 23-11 by part for 125mm/in speed. Coverage is 100%.
[0091] Since grain density is determined by dipping speed and concentration, it is managing this and concavo-convex control is possible for it. Moreover, equipment can be simplified if it is made to adhere by the dipping method. dipping -- being local (for example, an inner circumference side or a periphery side etc.) -- it can also carry out.
[0092] Particle 23-12a can also be considered as non-subtlety particles other than SiO2.
[0093] On particle layer 23-12A, chromium layer 23-12B with a thickness of about 80nm is formed. This chromium layer 23-12B functions as a switched connection film, is effective in improving magnetic properties, and can heighten especially coercive force.
[0094] On this chromium layer 23-12B, cobalt platinum layer 23-12C is formed covering the thickness of 40nm. furthermore, protective coat 23-12D which consists of SiO2 [with a thickness of 10nm] on this cobalt platinum layer 23-12C -- a spin coat -- or it is applied. On protective coat 23-12D, lubricant 23-12E is applied further. As this lubricant 23-12E, Z-DOL (trademark) of FOMBLIN can be used, for example.
[0095] Next, the rate of a data storage area and a servo data storage area is explained. As shown in drawing 12 , each segment is classified into a data storage area and a servo data storage area in this invention. Although the data storage area is flat, as the servo data storage area was mentioned above, servo patterns, such as a clock mark, wobble DOMAKU, and a Gray code, are recorded as a physical (also the sector number and track number of ID record section 20-41H which were correctly shown further in drawing 2) concavo-convex condition.
[0096] As typically shown in drawing 13 , therefore, on an arm 23-81 (arm 40-53 of drawing 19) Although the magnetic head is held at the slider 23-83 (slider 40-57 of drawing 19) currently supported through the load beam 23-82 (suspension spring 40-56 of drawing 19) This slider 23-83 is arranged to a magnetic disk 23-84 by the airstream generated corresponding to rotation of a magnetic disk 23-84 at a predetermined distance.
[0097] Since the magnetic variation detected by the magnetic head becomes large, a playback output also becomes large, so that the distance of the magnetic head therefore a slider 23-83, and a magnetic disk 23-84 is near. However, if the distance approaches too much not much, the magnetic head will contact a magnetic disk 23-84. Therefore, a slider 23-83 needs to hold a predetermined distance to a magnetic disk 23-84.
[0098] However, as mentioned above, since the surface of a magnetic disk 23-84 (magnetic disk 22-1 of

drawing 10) is not flat, corresponding to the irregularity, the distance of a slider 23-83 and a magnetic disk 23-84 changes. Supposing it is long enough and a servo data storage area has length comparable as a slider 23-83 to length L of a slider, the segment length S As shown in drawing 14 , a slider 23-83 While beginning to trespass upon a servo data storage area (crevice), after the point begins to sink, it pitches centering on the supporting point corresponding to this and the back end section loses temporarily touch with a stationary surfacing condition (surfacing condition in a flat field), the whole sinks soon. Transit is performed in the pars basilaris ossis occipitalis of a crevice, attenuating pitching excited at the time of crevice invasion.
[0099] When breaking away from a crevice, the point of a slider 23-83 is raised, a slider 23-83 pitches to the case and hard flow at the time of crevice invasion, and its back end section is temporarily depressed. Then, while the whole breaks away from a crevice and attenuates pitching movement, it returns to a stationary surfacing condition.
[0100] The above actuation is a thing in case a slider 23-83 overcomes one crevice. However, in fact, as mentioned above, a servo data storage area is generated periodically a segment period. In order to make the jitter of a clock small, it is desirable to shorten the period of a segment and to increase the number of the servo data storage areas per one truck. However, if it is made such, since data storage areas will decrease in number, the storage capacity of a disk will become small. For this reason, the number of servo data storage areas is determined by the trade-off with the storage capacity of a disk, and a jitter allowed value.
[0101] As now shown in drawing 15 , the rate to one segment of a servo data storage area is made into 23%, and it supposes in the meantime that it is a crevice altogether, and when it assumes that 77% of remaining data storage areas are heights, one crevice shown in drawing 14 gets over, and a property is overlapped on the component of a segment period. Drawing 16 is carried out in this way, and signs that the distance of a slider 23-83 and a magnetic disk 23-84 changes a segment period are shown. In addition, in drawing 16 , the number of 2700rpm and the segments per rotation is made [slider length] into 420 pieces for the rotational frequency of 1.8mm and a magnetic disk 23-84. This drawing shows that the distance of a slider 23-83 and a magnetic disk 23-84 changes a lot a segment period.
[0102]
[A table 1]

サーボデータ記録領域 ：データ記録領域	10 : 90	23 : : 77	30 : 70
変動量	13.0nm	28.0nm	32.0nm

[0103] A table 1 shows the value which calculated the amount of surfacing fluctuation at the time of servo data storage area riding **** of a slider 23-83 by the simulation by making the ratio of the data storage area per segment, and a servo data storage area into a parameter. the conditions in this simulation -- s, 420 per one truck and the flying height set [whenever / 45Hz and angle-of-skew] to 0.11 micrometers, and 12.8m /and a disk rotational frequency **** [the number of segments / peripheral velocity] at 0 times. Moreover, the depth of the crevice in a servo data storage area is set to 0.1 micrometers.
[0104] It turns out that the amount of fluctuation carries out sequential increase with 13.0nm, 28.0nm, or 32.0nm as are shown in this table 1 and the ratio to the data storage area of a servo data storage area increases ten pairs with 90 or 23 to 77 or 30 to 70. That is, it turns out that there are so few amounts of fluctuation of a magnetic disk and a slider 23-83 that there are few rates that a servo data storage area occupies. If the rate of a servo data storage area is made to increase, the record playback which the amount of fluctuation of a slider increased, fluctuation did not decline enough in the flat part when the

worst, but storage capacity not only becomes small, but was stabilized will become difficult. Then, it is desirable to make into 40% or less the rate of occupying to per one truck of a servo data storage area (field in which the crevice is formed).
[0105] Next, the point of the recording head section 10-3 of drawing 1 and the reproducing-head section 10-4 is explained.
[0106] In drawing 17 , the ABS (Air Bearing Surface) side 30-7 used as opposite ** with a magnetic disk or an opposed face is faced, and the laminating of the 1st and 2nd magnetic layers 30-3 which constitute the C dollar of the reproducing head, and 30-4 is carried out to the very thing (slider 23-83 of drawing 13) or the bases 30-6 which are attached in this, such as a surfacing mold slider. the MR element 30-1 which consists of MR (magnetic resistance effect) thin film so that it may be inserted into these magnetic layer 30-3 and 30-4, and bias -- a conductor 30-18 is arranged through the nonmagnetic insulating layer 30-8, and MR mold reproducing head is constituted. this bias -- a conductor 30-18 gives the magnetization condition of the necessary sense to the MR element 30-1, and it is arranged so that it may operate in the property field which shows the linearity excellent in that magnetic-reluctance property, and high sensitivity, and this MR element 30-1 may be crossed.
[0107] And the laminating of the 3rd magnetic layer 30-5 is carried out to the side in which it is prepared, the 2nd outside 30-1, i.e., MR element, of a magnetic layer 30-4, through the nonmagnetic insulating layer 30-8 in the opposite side. Between these 2nd and 3rd magnetic layers 30-4 and 30-5, the curled form pattern head coil (30-2 of drawing 18) is formed so that the portion each other magnetically combined between each back section estranged from this ABS side 30-7 may be revolved. Distance of the inferior surface of tongue of the 3rd magnetic layer 30-5 and the center of the MR element 30-1 is set to 3.5 micrometers.
[0108] Thus, while the 1st and 2nd magnetic layers 30-3 and MR mold magnetic head (reproducing head) of the so-called shield mold configuration by which the MR element 30-1 has been arranged among 30-4 are constituted, the 2nd and 3rd magnetic layers 30-4 and the Ind (induction) mold magnetic head (recording head) to which the magnetic path which consists of 30-5 was looped around the head coil are constituted.
[0109] At this time, the width of recording track of MR mold reproducing head is regulated by the width of face WTM which faces the ABS side 30-7 of the MR element 30-1, and the width of recording track of an Ind mold recording head is regulated by the width of face WTI which faces the ABS side 30-7 of the 3rd magnetic layer 30-5. the width of face WTM of the MR element 30-1 -- comparatively -- size -- 5.2 micrometers (width of face equal to a track pitch) -- carrying out -- the width of face WTI of the 3rd magnetic layer 30-5 -- comparatively -- smallness -- for example, it constitutes as 4.0 micrometers (width of face narrower than a track pitch).
[0110] Without causing the increment in a playback noise, when record playback was performed to the magnetic disk of the discrete mold which was made into track pitch 5.2micrometer, the width of recording track of 3.6 micrometers, and guard band width of face of 1.6 micrometers, namely, was set to track density 4885TPI (Track Per Inch) using the MR/Ind compound-die thin film head by such configuration, fluctuation of a playback output could be avoided and improvement in reproducing characteristics was able to be aimed at.
[0111] Next, the cross-section configuration of the magnetic head is explained with reference to drawing 18 . On the base 30-6, the ABS side 30-7 is faced and the laminating of the 1st and 2nd magnetic layers 30-3 which accomplish the shield of the MR element 30-1 on both sides of the MR element 30-1, and 30-4 is carried out. Besides, the nonmagnetic insulating layer 30-8 and the 3rd nonmagnetic magnetic layer 30-5 which constitute the magnetic gap at the time of record face the ABS side 30-7 similarly, and a laminating is carried out. Moreover, 30-2 shows the head coil formed in the curled form pattern so that the 2nd and 3rd magnetic layers 30-4 and 30-5, for example, the mutual magnetic bond part of each back section, may be revolved, and a recording head is constituted by these 2nd and 3rd magnetic layers 30-4 and 30-5.
[0112] The tip electrode 30-15 is formed in the ABS side 30-7 at the side which opposite-**, the back end electrode 30-16 is formed in the other end, and the MR element 1 is made as [detect / to the ABS

side 30-7 / opposite ** or the signal magnetic field from a magnetic disk which counters]. bias for 30-18 to give a bias magnetic field to the MR element 30-1 -- it is a conductor. The 2nd magnetic layer 30-4 functions as a core for induction as a C dollar of the MR element 30-1 at the time of record at the time of playback.
[0113] Distance (record gap) of the upper surface of the 2nd magnetic layer 30-4 and the inferior surface of tongue of the 3rd magnetic layer 30-5 is set to 0.6 micrometers, and distance of the center of the MR element 30-1 and the upper surface of the 1st magnetic layer 30-3 is set to 0.2 micrometers.
[0114] According to this compound-die thin film head, in order to make the width of recording track of the reproducing head into size, increase-ization of a playback output can be attained.
[0115] Furthermore, since tolerance to a location gap of the truck of the reproducing head and a magnetic disk can be made into size while being able to control generating of playback fringing when performing record playback to the magnetic disk of a discrete mold using such a compound-die thin film head, fluctuation of a playback output can be controlled and improvement in playback output characteristics can be aimed at.
[0116] In addition, width of face WTI and WTM may be made into the integral multiple of the width of recording track. Moreover, a recording head and the reproducing head can also be made to serve a double purpose.
[0117] Drawing 19 shows the structure of an arm where the magnetic head (a recording head and reproducing head) explained with reference to drawing 5 , drawing 6 , drawing 17 , drawing 18 , etc. is attached. As shown in this drawing, the bottom housing 40-51 is equipped with the magnetic disk 40-52 free [rotation] through the spindle motor (100-21 of drawing 59). Moreover, the arm 40-53 is attached in the bottom [this] housing 40-51 free [rotation] centering on the shaft 40-54. As shown to drawing 20 in a cross section, the ball bearing 40-55 is formed between the shaft 40-54 and the arm 40-53. Thereby, it is made as [become / friction at the time of rotation of an arm 40-53 / small].
[0118] The suspension spring 40-56 is attached at the tip of an arm 40-53, and the slider 40-57 is further attached through the gimbal spring of this suspension spring 40-56 which is not illustrated at a tip. The magnetic head (a recording head and reproducing head) mentioned above is attached in this slider 40-57. Since two magnetic disks 40-52 are formed and the magnetic film is prepared in the both sides, a total of four sliders are formed so that both sides of each disk may be countered.
[0119] The voice coil 40-63 (21-15 of drawing 6) is attached in the other end of an arm 40-53. In the lower part of this coil 40-63, and the upper part, a magnet 40-61 and 40-62 (21-14 of drawing 6) are arranged, and it is made as [face / locally / again / from a magnet 40-62 / to that reverse / from a magnet 40-61 / at a magnet 40-62 / to a magnet 40-61 / magnetic flux]. And the coil 40-63 is arranged so that this magnetic flux may be crossed. Consequently, if drive current is passed in a coil 40-63, electromagnetic force will occur, and a coil 40-63, therefore the arm 40-53 in which this is attached rotate a shaft 40-54 as a center. Consequently, a slider 40-57 will move to the predetermined radius location of a magnetic disk (therefore, the magnetic head attached there) 40-52.
[0120] Next, the point about the clock signal generation section 10-6 of drawing 1 is explained.
[0121] Drawing 21 is drawing showing the configuration of one example at the time of applying this invention to a magnetic hard disk drive unit. The rotation drive of double-sided magnetic-disk 50-1A and the 50-1B (40-52 of drawing 19) is carried out by the spindle motor 50-2. Magnetic-head 50-3A and 50-3B are supported by arm 50-4A and 50-4B, with a voice coil motor (VCM) 50-5, rotation center 50-5C is rotated by them as the supporting point, follow the truck 50-502 of the upper surface of double-sided magnetic-disk 50-1A and 50-1B, and perform writing and read-out of data to these trucks, respectively.
[0122] The truck 50-502 of two sheets, magnetic-disk 50-1A and 50-1B, constitutes a cylinder 50-100. Although not illustrated, the two magnetic heads which perform writing and read-out of data to the inferior surface of tongue of double-sided disk 50-1A and 50-1B are prepared, like magnetic-head 50-3A and 50-3B, it is supported by arm 50-4A and 50-4B, and rotation center 50-5C is rotated by VCM 50-5 as the supporting point. As explained with reference to drawing 2 , into the data tracks of the surface of magnetic-disk 50-1A and 50-1B, stamp formation of two or more clock marks 20-11 which

give a time-of-day standard is beforehand carried out at the time of disk manufacture. In addition, a reference number 50-6 shows the center of rotation of the center of rotation of a spindle motor 50-2, i.e., magnetic-disk 50-1A, and 50-1B.

[0123] A host computer 50-50 supplies commands, such as a write command and a read-out command, to a controller 50-70 through an interface cable 50-60. A controller 50-70 outputs the control signal for controlling a magnetic hard disk drive unit to a digital disposal circuit 50-20.

[0124] The regenerative signal read from disk 50-1A and 50-1B by magnetic-head 50-3A and 50-3B is amplified by predetermined amplitude by the playback amplifying circuit 50-21. The output of the playback amplifying circuit 50-21 is supplied to the clock extract circuit 50-22, the truck position error detector 50-23, the home index extract circuit 50-24, and the track-address decoder 50-80.

[0125] The playback clock signal (clock mark 20-11) extracted in the clock extract circuit 50-22 is supplied to the truck eccentricity test section 50-25. Moreover, it is supplied to the truck eccentricity test section 50-25, the home index signal 20-73 (drawing 4), i.e., the rotation phase zero signal, extracted by the home index extract circuit 50-24. The truck position error detector 50-23 generates a truck position error signal (tracking error signal) from the difference of one pair of wobble DOMAKU 20-12, and the regeneration level of 20-13, and supplies it to the tracking servo circuit 50-40 and the off-track judging circuit 50-90.

[0126] The eccentricity to the center-of-rotation shaft 50-6 of the data-tracks circle 50-502 is measured as a function of the angle location theta on the disk which makes the home index generating location of a disk zero angle coordinate value, and the truck eccentricity test section 50-25 makes the eccentricity storage section 50-26 memorize it in table format by the method of mentioning later. This eccentricity is supplied to the PLL circuit 50-30, is used for amendment of the time-base error of a clock signal, and also is supplied to the tracking servo circuit 50-40, and is used for control of VCM 50-5.

[0127] One [namely,] of the features of the example of this invention of drawing 21. Synchronizing with rotation of a disk, reading appearance of the eccentricity memorized by the storage section 50-26 is carried out by the read-out circuit 50-27. After being changed into the analog signal by D/A converter 50-28 and making compensation processing, i.e., the conversion to a speed signal, by the feedforward compensator 50-29, It is in the point which acts as feedforward as control voltage of the voltage controlled oscillator (VCO) 50-35 of the PLL circuit 50-30.

[0128] The loop filter 50-32 with which the PLL circuit 50-30 carries out predetermined filtering, such as low pass filtering, to the output of a phase comparator 50-31 and this phase comparator 50-31, The clock signal with which the phase comparator 50-31 was extracted by the clock extract circuit 50-22 including the phase according to the output of this filter 50-32, and the voltage controlled oscillator 50-35 which outputs the clock signal of frequency, It is outputted from a voltage controlled oscillator 50- and phase contrast with the clock signal fed back through one counting-down circuit 50-36 for N is outputted.

[0129] The feature of the example of this invention of drawing 21 forms an analog adder (operational amplifier) 50-33 between a loop filter 50-32 and VCO 50-35, adds the signal supplied through a switch 50-34 from the feedforward compensator 50-29 to the signal outputted from a loop filter 50-32, and is that it supplies to VCO 50-35. In addition, a loop filter 50-32 and an adder 50-33 may be digital arithmetic elements.

[0130] Since it has such composition, VCO 50-35 is driven also with the truck circle eccentricity display voltage which comes not only via the output from a phase comparator 50-31 but via the read-out circuit 50-27 from the eccentricity storage section 50-26, D/A converter 50-28, the feedforward compensator 50-29, and a switch 50-34. Therefore, VCO 50-35 also performs open loop actuation with the prediction signal of the current momentary eccentricity from the storage section 50-26 while following the pulse signal which is generated from a disk and which synchronized with the clock mark of 840 piece / 1 rotation, for example in the so-called closed loop actuation.

[0131] namely, the clock from the disk looked at which and observed in actuation of a disk with such eccentricity from the reproducing head fixed in the direction (hand of cut of a disk) of theta -- the direction of a time-axis -- the fluctuation of roughness and fineness (jitter) -- **** -- it is. The clock

signal outputted from the clock extract circuit 50-22 by most components which are equivalent to a rotational frequency (60Hz) among the components of this fluctuation when "excitation" of VCO 50-35 is intentionally carried out by the above-mentioned open loop actuation, and the clock signal outputted from VCO 50-35 are made to approach to the neighborhood in phase for about **20ns (nanosecond).
[0132] By phase approach by this open loop actuation, the above-mentioned closed loop actuation should just carry out actuation which mainly negates a high frequency component with the small amplitude (several times thru/or dozens times of a rotational frequency) among fluctuation components. Therefore, finally the output signal of VCO 50-35 can be held from the clock extract circuit 50-22 to the clock signal outputted to the very near oscillation phase for **1 or less ns.
[0133] As explained with reference to drawing 2 , since a data-tracks circle is manufactured by Kattan GUMASHIN with the delivery precision of about 0.01 microns like an optical disk manufacturing installation, the error of roundness serves as a value sufficiently smaller than 1 micron. However, if such a disk is attached in the axis of rotation (shaft 40-54 of drawing 19), a disk center, i.e., the center of a data-tracks circle, will produce 10 thru/or an about 50-micrometer installation error to the axis of rotation.
[0134] Although later mentioned with reference to drawing 25 thru/or drawing 23 about the details of the method of measuring this gap (eccentricity), with reference to drawing 22 , it explains briefly here.
[0135] In drawing 22 , a reference number 50-500 shows the center of a truck 50-502, and a reference number 50-501 shows the center of rotation of a disk. The reproducing head 50-3 is positioned in the tracking servo circuit 50-40 so that it may be supported by the arm 50-4 and the center top of a truck 50-502 may be traced.
[0136] Now, about the radius of a truck 50-502, when r0 (m) and eccentricity are set to delta (m) and a rotational frequency is set to N (Hz), the average peripheral speed V0 of a truck 50-502 is as follows.
[0137] V0=2pir0xN (m/sec)
[0138] It is M (an individual/1 rotation) about the pulse number by the clock mark (the drawing Nakamaru mark shows) included on the circular truck 50-502 of a radius r0. When it carries out, the distance L0 between pulses is as follows.
[0139] L0=2pir0/M[0140] The time amount T0 taken for this the reproducing head 50-3 to pass is as follows.
[0141] T0=L0/V0=(2pir0/M)/(2pir0xN) =1/(NxM)
[0142] For example, N= 60.0Hz, if it becomes M=840, it will be T0=19.841 (microsecondec).
It comes out.
[0143] On the other hand, the pulse period T2 of the portion which the radius increased to r2=r0+delta with eccentricity, and the pulse period T1 of the portion which decreased to r1=r0-delta are as follows.
[0144] T2=2pir0/M/(2pir2xN) =r0/r2x (NxM)
T1=2pir0/M/(2pir1xN) =r0/r1x (NxM)
[0145] It follows, for example, T2 is set to T0x1.0025 at the time of r0=20mm and r2=20.05mm, and it changes 0.25%. Although this is minute, since it is the amount of a time domain, it can measure with a comparatively sufficient precision.
[0146] That is, in this example, to T0=19.841 (microsecond), since it is T2=19.891 and T1=19.792 (microsecond), the average, and the maximum and the minimum value of T have a difference for about 50ns (nano second) respectively. Since this is measurable in precision sufficient with current electronic-circuitry technology, measurement of eccentricity results in measurement of a time interval.
[0147] Thus, creation of an eccentric table is completed by storing the progress delay of the signal corresponding to the eccentricity which carried out rear-spring-supporter observation in one rotation as a digital numeric value at the storage section 50-26.
[0148] Thus, feedforward control of VCO 50-35 by this invention which used the eccentric table memorized by the storage section 50-26 is performed as follows. First, synchronizing with the rotation phase of a disk, the contents of the storage section 50-26 are changed into read-out and a D/A converter from 50-28 by the read-out circuit 50-27 at analog voltage, and after at least ** carries out phase compensation by the feedforward compensator 50-29 which consists of a coil L, a capacitor C, and

resistance R (not shown) further, it is impressed by VCO 50-35 through a switch 50-34 and an analog adder 50-33. When not impressing a feedforward compensatory signal, the oscillation phase of VCO 50-35 changes a lot, as the continuous line of drawing 23 shows, but if it impresses, it will approach about 0 degree of rear spring supporters throughout 1 rotation like the dashed line of drawing 23 .
[0149] Drawing 24 shows the 2nd example of the clock signal amendment circuit of this invention. In the example of drawing 21 , although displacement (eccentricity) of a truck own [to rotation each location of a disk] was used as contents of storing of the storage section 50-26, after own displacement of a truck is temporarily stored in the temporary storage section 50-251, an operation equivalent to the feedforward compensator 50-29 of drawing 21 is beforehand performed by operation part 50-252, and it is stored in storage section 50-26A in the example of drawing 24 . Therefore, the amount memorized by storage section 50-26A serves as speed corresponding to eccentricity.
[0150] If it does in this way, there is an advantage which can omit the feedforward compensator 50-29 of drawing 21 . That is, although it is necessary to constitute from a high-speed element for real-time operation, the compensator 50-29, i.e., the filter, of drawing 21 , since what is necessary is just to perform about once on the 1st, eccentric measurement has the advantage which can constitute operation part 50-252 grade from a cheap general-purpose processor, if an operation equivalent to the compensator 50-29 of the example of drawing 21 like the example of drawing 24 will be performed beforehand. Furthermore, there is an advantage which can also realize difficult actuation in analog processing.
[0151] In the example of drawing 24 , contents selection section of storage 50-27A takes out alternatively the amount (namely, speed) corresponding to the eccentricity of two or more disk sides stored in storage section 50-26A based on the command from a controller 50-70.
[0152] In the example of drawing 24 , since it is the above configurations, after the eccentric measurement result obtained like the example of drawing 21 is adjusted to a necessary amplitude phase characteristic by operation part 50-252, it is stored in storage section 50-26A. This eccentric measurement actuation is repeat ****** independently about each field of two or more disks to the suitable stage for example, after an electric power switch injection. Since there is the 4th page, a disk is performed a total of 4 times using the arm head prepared corresponding to each side. Therefore, four kinds of eccentricity is accumulated in storage section 50-26A.
[0153] Here, a controller 50-70 explains the actuation at the time of choosing for example, disk 50-1B (referring to drawing 21). At this time, selection section 50-27A outputs from from the eccentric data detected by head 50-3B among the information memorized by storage section 50-26A synchronizing with rotation of disk 50-1B. It is equivalent to that by which the memory address was equivalent to the angle position coordinate on a disk, and the outputted eccentric data gave phase compensation to eccentricity [in / in storing data / this coordinate].
[0154] Therefore, if it is impressed by VCO 50-35 through an adder 50-33 after changing this into analog voltage by D/A converter 50-28, VCO 50-35 negates correctly progress ****** of the clock resulting from the eccentricity of a disk, and the output of VCO 50-35 can generate the pulse of the phase very near the clock reproduced from a disk.
[0155] The result of an operation to the eccentricity of operation part 50-252 is memorized to storage section 50-26A, and although he is trying to read the result of an operation corresponding to the disk side which should be processed, the eccentricity itself is memorized and you may make it read the eccentricity corresponding to the disk side which should be processed in the example of drawing 24 .
[0156] It can **, if according to the example of this invention mentioned above it becomes possible to reproduce the clock signal which synchronized with the clock mark stamped on the disk very correctly, and this clock is used for detection of a truck position error signal, or the recovery of a data sign, and a very good result is obtained. Moreover, the gain of an eccentric frequency region can be raised, without extending the band of a KURROKU playback loop.
[0157] Next, how to measure eccentricity is explained.
[0158] Drawing 25 shows relation with the locus of the reproducing head, i.e., a signal read-out arm head, fixed to the condition of being located in a fixed radius from the center of rotation of the magnetic disk with which the clock mark signal (20-11 of drawing 2) of N individual was physically recorded at

equal intervals for 1 round of circular data tracks, and the disk by which chucking was carried out. In drawing 25 , a reference number 51-500 shows the center of circular data tracks, data-tracks 51-D3 thru/or 51-D7 are formed in the shape of a concentric circle to this center 51-500, and clock mark signal 51-CM (20-11 of drawing 2) of N individual is physically recorded at equal intervals for 1 round of each data tracks.

[0159] When chucking of the magnetic disk which has the above circular data tracks is carried out to the spindle motor axis of rotation 51-501, eccentricity 51-511 arises. A reference number 51-503 shows the circle locus of the reproducing head, i.e., a signal read-out arm head, fixed to the condition of being located in the fixed radius 51-510 from the center of rotation 51-501 of the disk by which chucking was carried out. When the circle locus 51-503 approaches most the center 51-500 of circular data tracks, The time amount to which an arm head passes the distance 51-513 between clock mark signal 51-CMs on the circular data tracks along which the circle locus 51-503 passes becomes the shortest. When the circle locus 51-503 separates from the circular data-tracks center 51-501 most, the time amount to which an arm head passes the distance 51-514 during the clock mark on the circular data tracks along which the circle locus 51-503 passes becomes the longest. This is because the disk radius of gyration 51-510 is the same and the head transit rate is the same.

[0160] Therefore, the eccentricity corresponding to a disk angle location resulting from eccentricity 51-511 can be obtained by the clock mark regenerative signal reproduced, the reproducing head, i.e., the signal read-out arm head, fixed to the condition of being located in the fixed radius 51-510 from the center of rotation 51-501 of the disk by which chucking was carried out, carrying out time interval measurement, and using this.

[0161] Drawing 26 shows the example of a concrete configuration of the time interval measurement section 51-70 which constitutes the eccentricity test section 50-25 in drawing 21 , and the eccentricity operation part 51-25. The eccentricity Records Department 51-26 is equivalent to the eccentricity Records Department 50-26 of drawing 21 . The time interval measurement section 51-70 consists of examples of drawing 26 including a flip-flop 51-71, a counter 51-72, an inverter 51-73, a counter 51-74, an oscillator 51-75, and a switch 51-76. The eccentricity operation part 51-25 is constituted including CPU 51-251, memory 51-252, latch 51-253, 51-254, and a computing element 51-255. The eccentricity storage section 51-260 is constituted including memory 51-260. In addition, CPU 51-251 also has the memory access function to memory 51-252.

[0162] A flip-flop 51-71 outputs pulse signal 51-TD which cuts and changes to High and Low on TTL level, whenever clock mark regenerative-signal 51-CMS reproduced from a disk comes. It is reversed with an inverter 51-73, and this pulse signal 51-TD is supplied to a counter 51-74 while it is supplied to a counter 51-72 as it is.

[0163] Pulse signal 51-TD measures the time interval between High(s) using an oscillator 51-75, and a counter 51-72 outputs time interval measurement value 51-CTA. On the other hand, a counter 51-74 measures the time interval of High of the pulse signal outputted from an inverter 51-73, i.e., the time interval of Low of pulse signal 51-TD, using an oscillator 51-75, and outputs time interval measurement value 51-CTB.

[0164] SUITCHI 51-76 is outputted as counted value 51-250 by turns according to control signal 51-CNT to which CPU 51-251 outputs time interval measurement value 51-CTB outputted from time interval measurement value 51-CTA outputted from a counter 51-72, and a counter 51-74 based on home index signal 51-HIS (20-73 of drawing 4). Memory 51-252 carries out sequential storage according to control signal 51-CS2 and address 51-AS2 to which CPU 51-251 outputs the time interval measurement value (1 rotation one half) 51-250 of the individual supplied from a switch 51-76 (N+N/2) based on home index signal 51-HIS.

[0165] According to control signal 51-CS2 and address signal 51-AS2 which are outputted from CPU 51-251, reading appearance of the time interval measurement value memorized by memory 51-252 is carried out. The p-th time interval measurement value by which reading appearance was carried out is held at latch 51-253 according to latch signal 51-LHA outputted from CPU 51-251. The time interval measurement value (sampling position which the disk rotated 1/2 from the p-th sampling position) of

eye ** (p+N/2) watch reading appearance was carried out is held at latch 51-254 according to latch signal 51-LHB outputted from CPU 51-251.

[0166] A subtractor 51-255 subtracts the time interval measurement value of eye ** (p+N/2) watch from the p-th time interval measurement value. A subtractor 51-255 performs this subtraction about each of p= 1 thru/or N. According to control signal 51-CS1 and address signal 51-AS1 which CPU 51-251 outputs based on home index signal 51-HIS, the sequential storage of the subtraction result of N individual obtained from a subtractor 51-255 is carried out at memory 51-260.

[0167] The subtraction result memorized by memory 51-260 Are the eccentricity corresponding to a disk angle location, and the distance resulting from the eccentricity of circular data-tracks 51-D3 and the head locus 51-503 (refer to drawing 25) is expressed. According to control signal 51-CS1 and address signal 51-AS1 which CPU 51-251 outputs based on home index signal 51-HIS, reading appearance is carried out as eccentricity 51-261, and it can use as an eccentricity table for performing eccentric amendment.

[0168] Drawing 27 is drawing in the example of a configuration of drawing 26 showing the relation between clock mark regenerative-signal 51-CMS and the time interval measured. In drawing 27 , when the counted value of the time interval of n-th clock mark regenerative-signal 51-CMS and clock mark regenerative-signal 51-CMS of eye ** (n+1) watch was expressed as t (n) and counted value when the circle locus 51-503 of drawing 25 separates from the circular data-tracks center 51-500 most is set to t (k), the counted value when approaching most is set to t (k+N/2).

[0169] the counted value train 51-250 memorized by an example 51-252 of the time interval of the clock mark regenerative signal measured by the time interval measurement section 51-70 which drawing 28 consisted of like drawing 26 , i.e., memory, -- a data number (sampling number) -- relating -- a table -- it is a thing the bottom. In drawing 28 , counted value when the circle locus 51-503 of drawing 25 separates from the circular data-tracks center 51-500 most is t (k), and the counted value when approaching most is t (k+N/2).

[0170] Drawing 29 expresses the distance resulting from an example of the eccentricity memorized by relating with the memory 51-260 of the eccentricity storage section 51-26 constituted like drawing 26 at the angle of rotation of a disk, i.e., the eccentricity of circular data tracks and the head locus 51-503 (refer to drawing 25), and is as mentioned above as a result of [which subtracts the time interval measurement value of eye ** (p+N/2) watch, and is obtained from the p-th time interval measurement value] eccentric measurement. As an eccentricity table corresponding to a disk angle location, the data stream 51-261 memorized by memory 51-260 can be used in order to perform eccentric amendment.

[0171] Drawing 30 shows the configuration of other examples of the eccentricity test section 25 of drawing 21 . measurement of the time interval of clock mark regenerative-signal 51-CMS of eye ** (n+m) watch (n is the integer of either 1 thru/or N) time interval measurement section 51-70C used home index signal 51-HIS, and were reproduced from the disk, and clock mark regenerative-signal 51-CMS of eye ** (n+m +1) watch -- m= 0 -- or (N+N / 2-1) carries out about integral each. According to control signal 51-CS8 and address signal 51-AS8 which memory access section 51-251C outputs based on home index signal 51-HIS, the sequential storage of the time interval measurement value measured by time interval measurement section 51-70C is carried out at memory 51-252C.

[0172] According to control signal 51-CS8 which memory access section 51-251C outputs based on home index signal 51-HIS, and address signal A51-S8, reading appearance of the time interval measurement value memorized by memory 51-252C is carried out. Adder 51-255C performs N/2 addition (namely, addition for 1/2 rotation) from the p-th time interval measurement value by which reading appearance was carried out to the time interval measurement value of eye ** (p+N/2) watch about each of the integer of p= 1 thru/or N. According to control signal 51-CS9 and address signal 51-AS9 which memory access section 51-251C outputs based on home index signal 51-HIS, the sequential storage of the addition result obtained by adder 51-255C is carried out at memory 51-256C.

[0173] On the other hand, 1-/N of the addition result which N individual part addition (namely, addition for one rotation) of the addition result obtained by adder 51-255C was carried out by adder 51-257C, and was obtained by adder 51-257C is carried out by divider 51-258C, and average 51-AV3 is

[0174] According to control signal 51-CS9 and address signal 51-AS9 which memory access section 51-251C outputs based on home index signal 51-HIS, reading appearance of the addition result memorized by memory 51-256C is carried out one by one. Subtractor 51-259C performs subtraction of the average AV3 about each of the integer of k= 1 thru/or N from the k-th subtraction result by which reading appearance was carried out. According to control signal 51-CS10 and address signal 51-AS10 which memory access section 51-251C outputs based on home index signal 51-HIS, the sequential storage of the subtraction result subtractor 51-259C Obtained is carried out at memory 51-260C.
[0175] The subtraction result memorized by memory 51-260C Are the eccentricity corresponding to a disk angle location, and the distance resulting from the eccentricity of circular data-tracks 51-D3 and the head locus 51-503 (refer to drawing 25) is expressed. According to control signal 51-CS10 and address signal 51-AS10 which memory access section 51-251C outputs based on home index signal 51-HIS, reading appearance is carried out as eccentricity 51-261C. It can use as an eccentricity table for performing eccentric amendment. Therefore, the example of drawing 30 can shorten the counter length which uses it for time interval measurement while being able to reduce a noise.
[0176] Drawing 31 shows the relation of the clock mark regenerative signal and measured time interval 51-250C in the example shown in drawing 30 . In drawing 31 , the time interval of 2nd clock mark regenerative-signal 51-CMS and the clock mark regenerative signal of eye ** (n+1) watch is t (n).
[0177] Drawing 32 is drawing showing average 51-AV3 outputted from time interval 51-250C of the clock mark regenerative signal which was measured by time interval measurement section 51-70C, and was memorized by memory 51-252C, and divider 51-258C in the example shown in drawing 30 . Time interval measurement section 51-70C measures the minimum time basis which a measurement means has. Time interval data stream 51-250C by which the minimum time basis was measured to eccentricity when coarse becomes step-like to a disk angle location. If severalN/2 which add time interval data stream 51-250C measured in the shape of a step in adder 51-255C are large enough, the eccentric information acquired is smoothly reproducible to a disk angle location.
[0178] an example of the eccentricity which drawing 33 is related with the angle of rotation of a disk at memory 51-260C in the example shown in drawing 30 , is alike, and is memorized -- 51 to 261 C Namely, data stream 51-261C which expressed the distance resulting from the eccentricity of circular data-tracks 51-D3 and the head locus 51-503 (refer to drawing 25), and was memorized by memory 51-260C As an eccentricity table corresponding to a disk angle location, it can use in order to perform eccentric amendment.
[0179] In addition, although eccentricity was measured from the clock mark above, you may make it measure from the servo pattern currently recorded on the servo data storage area 20-40 shown in drawing 2 (the unique pattern 20-72, Gray code 20-71, wobble DOMAKU 20-12, 20-13, etc.).
[0180] Next, the point about the tracking servo section 10-7 of drawing 1 is explained.
[0181] Drawing 34 shows the configuration of one example in the case of carrying out tracking control in a magnetic disk drive. The rotation drive of the magnetic disk 60-2 (50-1A [of drawing 21], 50-1B) is carried out by the spindle motor 60-8. It is supported by the arm 60-12, it is rotated by the voice coil motor (VCM) 60-14, and the magnetic head 60-10 (it has the configuration shown in drawing 17 and drawing 18) performs writing and read-out of data to a magnetic disk 60-2.
[0182] As explained with reference to drawing 2 , the truck 60-4 of the shape of a concentric circle and spiral a large number is formed in a magnetic disk 60-2, and the servo pattern of ** (Gray code 20-71) for positioning an arm head 60-10 (tracking control) and a precision (wobble DOMAKU 20-12, 20-13) is beforehand recorded on the truck 60-4. The axis of rotation of a spindle motor 60-8 is driven for example, by 3600rpm.
[0183] The playback amplifying circuit 60-21 amplifies the output of the magnetic head 60-10, and outputs it to the truck position error detector 60-23 and the track-address decoder 60-32. The track-address decoder 60-32 reads the track address of a Gray code in an input signal, and outputs it to the location generator 60-36 by making the difference into a rough signal as compared with the address of a desired truck (it should access). The truck position error detector 60-23 detects the signal corresponding

to wobble DOMAKU from an input signal, and outputs the tracking error signal corresponding to the gap from the truck of the magnetic head 60-10. A/D conversion of this signal is carried out by A/D converter 60-34, and it is supplied to the location generator 60-36.

[0184] The location generator 60-36 adds the output of the track-address decoder 60-32, and the tracking error signal which A/D converter 60-34 outputs, and generates a position signal (final tracking error signal).

[0185] The feedback control section 60-40 is a signal (it corresponds to the location which should arrange the magnetic head, and when the location is the center of a truck) which shows the servo criteria of the position signal from the location generator 60-36, and a truck. The subtractor 60-41 which outputs a position error signal in quest of the difference from which this signal is set to 0, The component 60-42 for performing PID (Proportional plus Integral plus Derivative action) actuation (PID action) to this position error signal, 60-43, and 60-44, It has the adder 60-45 adding the output of these components. The feedback control section 60-40 drives VCM 60-14 through D/A converter 60-70 and the drive amplifier 60-80, and performs actuation (the so-called closed loop actuation) which positions the magnetic head 60-10 in the criteria location (usually center) of a truck 60-4. The above is well-known technology.

[0186] The feature of the example of this invention of drawing 34 is in the point of having formed the adder 60-56 which adds the point of having formed the feedforward control section 60-60 which has the eccentricity storage section 60-26, the signal which carried out phase compensation (equalizing) of the output signal of this feedforward control section 60-60 in the phase compensating network 60-75, and the output signal of the feedback control section 60-40, and is supplied to D/A converter 60-70. As the eccentricity storage section 60-26 which constitutes this feedforward control section 60-60, the eccentricity storage section 50-26 (eccentricity storage section 51-26 of drawing 26) of drawing 21 can be used as it is. That is, as explained with reference to drawing 25 thru/or drawing 33 , the data corresponding to eccentricity is memorized by the eccentricity storage section 60-26.

[0187] The feedforward data memorized by the eccentricity storage section 60-26 is referred to to the same timing as the time of the eccentric measurement actuation for one above-mentioned rotation, and is outputted as a feedforward control output 60-57. After phase compensation (phase leading) of this signal is carried out by the phase compensating network 60-75, it is inputted into an adder 60-56. After an adder 60-56 adds this signal to the output 60-52 of the feedback control section 60-40, it is supplied to the VCM drive amplifier 60-80 through A/D converter 60-70. The drive amplifier 60-80 drives VCM 60-14 according to this.

[0188] What is necessary is just to use the signal with which the arm head 60-10 reproduced the servo pattern 60-6 (for example, clock mark mentioned above) recorded on the disk 60-2 as a reference signal for referring to the controlled-variable data of the eccentricity storage section 60-26 to the same timing as the time of measuring eccentricity, the angle-of-rotation signal of a spindle motor 60-8, etc.

[0189] The principle is as follows although the closed loop control constituted from the location generator 60-36, the feedback control section 60-40, D/A converter 60-70, and VCM drive amplifier 60-80 by taking the above-mentioned configuration can decrease further the stationary positioning deflection to a target truck criteria location.

[0190] Drawing 35 is the block diagram which simplified the example of drawing 34 . the transfer function of the circuit system 60-40, i.e., the feedback control section, in which 60-151 drives VCM 60-14 among drawing 35 , the transfer function of VCM 60-14 whose 60-152 is a controlled system, and r -- the reference value of an aim truck, and x -- a head location and d -- truck eccentricity and y -- an observation post -- it comes out, and it is and this is the same as that of well-known technology. Uff is the feedforward control output newly added by this invention.

[0191] The following formula can show residual disturbance component d' in drawing 35 .

d' = d+G (jomega), Uff [0192] However, when tracking control is carried out using the feedforward data calculated by the above-mentioned method, the feedforward control output Uff is set to Uff =-inverse (G (jomega)) and d, however G (jomega) and inverse(G (jomega)) = 1, and obtains d' = 0 from this.

[0193] Therefore, according to the example of this invention of drawing 34 , the effect of truck

eccentricity can be negated and the stationary positioning deflection to an aim truck center can be decreased.

[0194] As mentioned above in this invention, while forming a truck in a magnetic disk beforehand with a stamp, a clock mark besides the servo mark of wobble DOMAKU, a Gray code, and others, a sector number, a track number, etc. are beforehand fabricated with a stamp. Thus, when a predetermined mark builds the magnetic disk by which stamp formation was carried out beforehand into the housing mentioned later, it cannot be avoided that the eccentricity of about 50 micrometers occurs. In order to perform exact record playback, as for the location gap error of a truck and the magnetic head, being referred to as about 0.1 micrometers is desirable.

[0195] for example, ISO- the magneto-optic disk of the 130mm diameter of the sample DOSABO method defined by 10089 (B) -- setting -- 1367 pieces -- moreover -- the magneto-optic disk of the 90mm diameter of the sample DOSABO method defined by ANSI-X3.213-1993 -- 1472 pieces -- it is made as [form /, respectively / about disk 1 rotation (1 round) / a servo field]. Therefore, if this is rotated by 60Hz, the sampling rate of servo data will be set to 80kHz thru/or 88kHz. Thereby, a position signal with a band 40kHz or less is acquired.

[0196] Since the tracking servo of the optical arm head used for record playback of a magneto-optic disk is only a configuration which drives the minute objective lens which irradiates a laser beam with a voice coil to a magneto-optic disk, for example, as a dashed line shows to drawing 36 , it can constitute a tracking servo system from which gain is set to 1 by about 30kHz. When setting the rotational frequency of a disk to 60Hz, the gain becomes about 500 times. Therefore, even if there is eccentricity of 50 micrometers, a following error can be oppressed to about 0.1 micrometers.

[0197] On the other hand, in the magnetic disk drive made applicable [of this invention] to application, as mentioned above, the arm holding the magnetic head is supported free [rotation] by the ball bearing, and tracking control is performed by rotating this arm. Therefore, the mass of the section for a drive is very larger than the case in an optical arm head, and mechanical resonance occurs near 10kHz.

[0198] For this reason, on the whole, the gain of the tracking servo system in the magnetic disk drive shown in drawing 36 as a continuous line is raised, and if it is made to move to the location shown by the drawing destructive line, an oscillation will occur [near the mechanical resonance frequency]. For this reason, gain of the whole servo system cannot be enlarged.

[0199] Moreover, if the gain of the whole tracking servo system is raised, since the gain of a high region will also go up, the sampling frequency of servo data must be enlarged according to the theorem of nyquist. Since this means increasing the number of the servo data per one truck, it means that the storage capacity of a disk becomes small so much.

[0200] Moreover, if it is set as the magnitude which shows the gain of servo system as a continuous line in drawing 36 , since only about 50-time gain can be conversely acquired in 60Hz which is a rotational frequency, deflection of 50 micrometers cannot be oppressed to about at most 1 micrometer.

[0201] However, according to this example, as mentioned above, in 60Hz which is a rotational frequency, a feedforward signal is added to the usual tracking error signal. Consequently, the gain on the appearance of a tracking servo system becomes large locally in the frequency of 60Hz, as shown in drawing 37 . With this feedforward signal, since about 10-time gain can be acquired, 1 micrometer of residua by the closed loop mentioned above can be oppressed to 0.1 micrometers. Thereby, after all, in the frequency of at least 60Hz, 500 times as many gain as this is able to be acquired, and the deflection of 50 micrometers can be oppressed to 0.1 micrometers.

[0202] Thus, if it is made to raise gain only [near the rotational frequency] and is made not to raise the whole gain, compared with the case where the whole gain is raised, single [about] figure frequency which becomes gain 1 can be made small. That is, when the dashed line of drawing 36 shows, it is 30kHz, but it is set to 3kHz when the continuous line of drawing 37 shows.

[0203] By the theorem of nyquist, a sampling frequency required for reappearance of the positional information to 3kHz is at least 6kHz. However, since the frequency of this nyquist is frequency just before losing information, that the one 10 times sampling frequency [5 thru/or] of this is required for it practical. For this reason, a practical sampling frequency is set to 6kHzx10/60Hz=1000 (a piece/round).

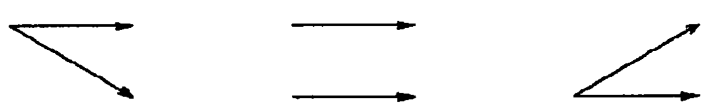
That is, there should just be 1000 servo data storage areas per round. As a result of the experiment, when the number of the servo data storage areas per round was made into 840 pieces or 420 pieces, the good positioning property was able to be acquired.
[0204] Next, the point which detects an off-track among the points about the tracking servo section 10-7 of drawing 1 is explained.
[0205] Drawing 38 shows the configuration of one example of the detector which detects an off-track. The tracking error signal which the truck position error detector 50-23 in drawing 21 outputs is supplied to the window comparator 70-1. The reference voltage which the reference voltage generating circuit 70-2 outputs is supplied to this window comparator 70-1 again. As this reference voltage, the reference voltage as a top threshold which constitutes a window, and the reference voltage as a bottom threshold are contained.
[0206] That is, the window comparator 70-1 compares a tracking error signal with these two thresholds, its level of a tracking error signal is larger than a top threshold, or when smaller than a bottom threshold, it outputs a detecting signal to the judgment circuit 70-3. The judgment circuit 70-3 judges whether record actuation is stopped from the inputted signal, and outputs a judgment result to the Records Department 10-9 of drawing 1 . At the Records Department 10-9, when this signal is inputted, record actuation is suspended.
[0207] Next, with reference to the flow chart of drawing 39 , detailed judgment actuation of the window comparator 70-1 and the judgment circuit 73-3 is explained.
[0208] In step S70-1, it judges first whether a tracking error signal exists in a window. This step is judged by the window comparator 70-1. When a tracking error signal exceeds the range of a window, the number is set to Variable N in step S70-2. That is, Variable N shows the count to which the level of a tracking error signal exceeded the range of a window.
[0209] Next, it progresses to step S70-3 and the count of continuation to which the tracking error signal exceeded the range of a window is memorized. That is, a tracking error signal is sampled whenever wobble DOMAKU comes (with segment period), but the count is memorized when the range of a window is exceeded by the continuous segment. And in step S70-4, it is judged whether the memorized count of continuation is 3 times or more. When it is not three continuation, it progresses to step S70-5 and it is judged whether three samplings have exceeded the range of a window among the past four samplings. Step S If it progresses to step S70-6 and is not ordered in termination when the judgment in 70-5 is also NO, return and the same processing are repeated by step S70-1.
[0210] Step S In 70-4, when [that there were three counts exceeding the range of a window continuously] judged, or when [to which three of the past four samplings have exceeded the range of a window in step S70-5] it is judged, it progresses to step S70-7 and the pulse which suspends record actuation is outputted. This pulse is supplied to the Records Department 10-9 of drawing 1 , and the Records Department 10-9 suspends record actuation, when this pulse is inputted. Step S The processing after step S70-6 is repeated by the degree of 70-7.
[0211] That is, when the location data which separates from a detection window is generated more than predetermined frequency since the servo data storage area is formed so that location data may be obtained by the high frequency called 25kHz, he is trying to suspend record actuation for the first time in the magnetic disk of this example.
[0212] When the range of a window is exceeded even once, it is also theoretically possible to make it stop record actuation immediately. In this case, when narrowing width of face of a window and a big impact is added to a magnetic disk drive, it can prevent certainly that the magnetic head will move to the next truck and data will be recorded there. However, if width of face of a window is made not much narrow, when few noises occur, record actuation will be suspended immediately, and a throughput will fall. Conversely, if width of face of a window is made large too much, even when the noise of hard flow occurs and it will have moved to the truck which adjoins in fact, what it becomes impossible to detect this and records data on the next truck accidentally occurs.
[0213] Then, as mentioned above, when off-track detection is carried out by predetermined frequency, it is desirable to make it suspend record actuation.

[0214] A window is set as width of face equal to positive/negative both directions centering on a criteria location. When setting width of face (one half of width of face of a window) from the criteria location of this window to 0.75 micrometers (the level of a tracking error signal and the relative location gap from the criteria location of the truck of the magnetic head can be made to correspond), error detection probability when the impact of 10G is added can be made or less into ten to three by performing judgment processing mentioned above. Moreover, when the impact of 100G is added, the amount of an off-track can make probability that record actuation can be suspended 95% or more, in a condition 0.95 micrometers or less.
[0215] Next, the reason is explained.
[0216] Suppose that the near imbalance of one rotation center [that the magnetic head is attached now] side of an arm, and another side is 0.1 or less gcms, the sampling frequency of wobble DOMAKU is 25kHz, and S/N of a position signal is 31dB (the ratio will be set to 31dB, if the width of recording track is set to 5 micrometers and the gap by the noise is set to 0.07 micrometers).
[0217] Inertia J of an arm is set to 1.06x103gmm2, and length r of an arm is set to 36mm further again. And when there is arm imbalance of 0.1gcm, the result of a simulation when the shock of 10G is added is shown in drawing 40 (drawing 40 shows the case of the magnitude whose shock is 10G, and the case of the magnitude of 100G). A 0.12-micrometer off-track arises at one side so that more clearly than this drawing (to the left or right). Among these, an off-track presupposes that it may incorrect-detect in the section used as 0.1 micrometers or more. Moreover, the time amount of this section is set to about 1.8ms (45 samples).
[0218] The greatest off-track at the time of the shock of 10G is 0.6 micrometers. Then, when it assumes that it is what has produced the period for 1.8ms (45 samples), and the 0.6-micrometer off-track, the probability of incorrect detection was estimated and S/N of a position signal is set to 31dB, the probability observed by 0.15 micrometers or more shifting to one side rather than a real location is set to 1.62x10-2. When having produced the 0.6-micrometer off-track from this, that in which three or more samples have separated from the window (less than 0.75 micrometers), and the probability incorrect-detected are set to 1.68x10-5 among continuous 4 samples. Among 4 samples which the arbitration within this section (45 samples) follows, since the probability for three or more samples to be detected by separating from a window becomes these about 40 times, it is set to about 7x10-4, and ten to three or less are the incorrect detection probability.
[0219] On the other hand, when there is arm imbalance of 0.1gcm and the shock of 100G is added as shown in drawing 40 (a), the off-track after shock impression comes to be shown in drawing 40 (b). It turns out that the **1.2-micrometer off-track exceeding the range (**0.75 micrometers) of a window has occurred as shown in this drawing, and it is necessary to stop record.
[0220] Drawing 41 expands and shows the response immediately after shock impression. In the section whose off-tracks are 0.7 micrometers thru/or about 0.9 micrometers, it turns out that the magnetic head moves at the rate of about 0.03 micrometers / sampling. Since the migration locus of an arm head changes under the effect of a noise in fact and speed is also fluctuated, the case where it moves at the rate of 0.04 micrometers / sampling is considered supposing the case of being the worst.
[0221] Drawing 42 expresses signs that the magnetic head carries out the off-track, when it does in this way and the impact of 100G is added. In an off-track condition 0.95 micrometers or less, although what is necessary is just to be able to detect an off-track, when a gap (a maximum of 1 sample existence is recognized) of location detection timing is taken into consideration, in drawing 42 , it is desirable that it is detectable that there was an off-track at the time of a 0.91-micrometer off-track. Then, it will become 95.1% if the probability which will be detected as that in which three or more samples separated from the window (less than [**0.75micrometer]) among 4 samples with which arbitration continues at the time to the off-track location of 0.91 micrometers if the magnetic head moves along with the locus of drawing 42 as a thing according to the normal distribution whose noise is mho=0.07micrometer is searched for.
[0222] Even when it moves from this along with loci other than the locus which the magnetic head shows to drawing 42 , it turns out by 95% or more of probability that detection of an off-track is possible

in the state of an off-track 0.95 micrometers or less (when location detection timing has shifted).
[0223] Incidentally, since the detection ratio of the time of the 0.95-micrometer off-track of drawing 42 becomes 99.7%, even if the worst, in less than 0.99 micrometers, detection of an off-track is expectable.
[0224] Drawing 43 sets S/N to 31dB, and expresses the example of a response over the impact of 100G in the simulation adding a noise. In this drawing, the amount of off-tracks with an actual dashed line is expressed, and the continuous line expresses the observation post. In this case, when set to about 0.9 micrometers of 4 sample eye, an off-track gap is detected, and when it is 0.95 micrometers or less, it is possible, after the amount of off-tracks exceeds 0.75 micrometers as a threshold of a window to stop record.
[0225] Thus, compared with the case where carry out preparing a piezoelectric device in the interior of a magnetic disk drive etc., and an impact is detected by detecting an impact from a tracking error signal, an impact is detected very quickly, and it becomes possible to suspend record actuation.
[0226] Next, the point of the playback section 10-8 of drawing 1 is explained.
[0227] decoding the data reproduced from the magnetic disk with which data and various kinds of marks are recorded as it mentioned above -- for example, - although the 3 value level detection method by three thresholds, 2, 0, and +2, can be considered, while it has the advantage that circuitry is easy and ends, it has the defect that ability to detect is comparatively low.
[0228] Therefore, like the ID section (Gray code 20-72 of drawing 2 , sector number 20-41a, a track number 20-41b1, 20-41b2) of a sector, if this decoding method considers that defect, after decoding ID, it is unsuitable [applying, when decoding the data of a data area] for the portion which should judge quickly whether data is written into that sector at any rate.
[0229] Then, it is "Viterbi Detection of Class IV Partial Response on a Magnetic Recording Channel", using data as the method of carrying out record playback at a magnetic disk using a partial response method. The algorithm of the so-called Wood indicated by IEEE TRANSATIONS ON COMMUNICATIONS, VOL.COM-34, NO.5, MAY 1986, etc. is known.
[0230] Condition <-1> -> condition [which simplifies the Viterbi algorithm with the algorithm of Wood stated by this reference in accordance with the partial response (1 -1) of a pair equivalent to the partial response class IV (partial response (1, 0, -1)), and a survival pass pattern shows drawing 44] <-1>, and condition <-1> -> condition <+1> (this drawing (a))
Condition <-1> -> condition <-1> and condition <+1> -> condition <+1> (this drawing (b))
Condition <+1> -> condition <+1> and condition <+1> -> condition <-1> (this drawing (c))
By judging any of the ** 3 patterns it becomes, it is made as [obtain / the decode data with which the error rate has been improved].
[0231] Here, three survival pass patterns are hereafter made to express with three sorts of two literal notations ->** (upward emission), ->-> (parallel pass), and ->** (downward emission), respectively.
[0232] That is, according to the algorithm of Wood, when upward emission (->**) or upward downward emission (->**) appears as a survival pass pattern, the pass from the point (location p) where the emission before one appeared from the point (location k) to the point (location k) can be decided, and it is made as [decode / data] by repeating this.
[0233] Using the algorithm of such Wood, drawing 45 decodes the data from a magnetic disk (it has the format shown in drawing 2), and shows the example of a configuration of the regenerative circuit 80-80 which performs the error detection further.
[0234] In the synthetic circuit 80-2, based on the timing of the change over signal which the change over circuit 80-1 outputs, it is restored in order of origin and the data from a magnetic disk is outputted, after being inputted into the processing circuit 80-10 or 80-20 and processing the even number train sample an odd number train sample according to an individual, respectively.
[0235] In addition, although the configuration of the processing circuit 80-10 which processes an even number train sample is shown in details, the processing circuit 80-20 which processes an odd number train sample consists of drawing 45 similarly.
[0236] In the processing circuit 80-10, the data from a magnetic disk is supplied to a subtractor circuit 80-12 and register 80-13b through the switch 80-11 which carries out ON/OFF to the timing of an even

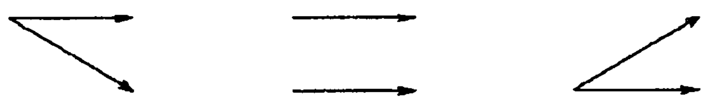
number train sample / odd number train sample corresponding to the change over signal (even/odd -1 (a bar (-) is given to odd and drawing is shown)) outputted from the change over circuit 80-1. That is, the even number train sample of the data from a magnetic disk is supplied to a subtractor circuit 80-12 and register 80-13b.
[0237] Register 80-13b memorizes the sampled data yp in the emission point in front of one, and from the inputted even number train sample (even number train sample of the data from the magnetic-disk section 10-2) yk, a subtractor circuit 80-12 subtracts the value yp memorized by register 80-13b (yk-yp) (calculating), and outputs it to a comparator circuit 80-14.
[0238] + whose comparator circuit 80-14 is a threshold -- corresponding to beta memorized by 2, 0, -2, the output (yk-yp) of a subtractor circuit 80-12, and register 80-13a, data processing shown in a table 2 and a table 3 is performed, and the output data shown in a table 2 and a table 3 are outputted corresponding to the result of an operation. The details of this operation are later mentioned with reference to drawing 46 .
[0239]
[A table 2]

$\beta=1$のとき			
入力条件 条件パターン	$y_k-y_p\leqq-2$ A	$-2<y_k-y_p\leqq0$ B	$0<y_k-y_p$ C
更新のルール	$y_p \leftarrow y_k$ $\beta \leftarrow -1$	$y_p \leftarrow y_p$ $\beta \leftarrow \beta$	$y_p \leftarrow y_k$ $\beta \leftarrow +1$
出力データ	new $\beta=-1$ UPDATE=1 DATA=1 p or k=p	new $\beta=*$ UPDATE=0 DATA=0 p or k=k	new $\beta=1$ UPDATE=1 DATA=0 p or k=p



[0240]
[A table 3]

$\beta = -1$ のとき			
入力条件 条件パターン	$y_k - y_p \leqq 0$ D	$0 < y_k - y_p \leqq 2$ E	$2 < y_k - y_p$ F
更新のルール	$y_p \leftarrow y_k$ $\beta \leftarrow -1$	$y_p \leftarrow y_k$ $\beta \leftarrow \beta$	$y_p \leftarrow y_k$. $\beta \leftarrow +1$
出力データ	new $\beta = -1$ UPDATE=1 DATA=0 p or k=p	new $\beta = *$ UPDATE=0 DATA=0 p or k=k	new $\beta = 1$ UPDATE=1 DATA=1 p or k=p



[0241] Here, as shown in a table 2 or a table 3, beta takes the value of either +1 outputted from a comparator circuit 80-14 or -1, when the emission before one is upward emission (->**), 1 is set to beta, and -1 is set to beta when the emission before one is downward emission (->**). Therefore, beta shows the class (was the emission before one upward emission, or was downward emission?) of emission before one.
[0242] A register 80-15 carries out counting of the PLL clock outputted from PLL which is not illustrated, and memorizes enumerated data k (sampling time). A register 80-16 memorizes the enumerated data k of a register 80-15 as p (time of day to which the emission before one came) corresponding to the updating instruction (UPDATE) which a comparator circuit 80-14 outputs. A selection circuitry 80-17 chooses the value p which a register 80-16 memorizes, or the value k which a register 80-15 memorizes corresponding to the selection command (p or k) which a comparator circuit 80-14 outputs.
[0243] RAM 80-18 writes the output data (DATA) from a comparator circuit 80-14 in a memory cell by making the output (p or k) of a selection circuitry 80-17 into a write address. A counter 80-19 carries out counting (count-up) of the number of the data written in RAM 80-18 based on the reference clock which the circuit which is not illustrated outputs, and RAM 80-18 sends out the data of all memory cells to coincidence in the synthetic circuit 80-2, after the writing of the data to all memory cells is completed based on the enumerated data of a counter 80-19. The synthetic circuit 80-2 returns and outputs the even number train sample from the processing circuit 80-10, and the odd number train sample from the processing circuit 80-20 to the original array based on the change over signal (even/odd -1) from the change over circuit 80-1.
[0244] if a configuration as shown in this drawing 45 is used and it will hit performing Viterbi decoding of data -- square -- a vessel becomes unnecessary, an adder can be managed with one piece and a comparator can be managed with two pieces. It is necessary to prepare RAM 80-18 for correcting, in addition memorizing pass.
[0245] Using the updating instruction (UPDATE) and output data (DATA) from the change over signal

(even/odd -1) from the change over circuit 80-1, and the processing circuit 80-10, and the updating instruction (UPDATE) and output data (DATA) from the processing circuit 80-20, the shift register arithmetic circuit 80-3 is made as [perform / a CRC operation], if Viterbi decoding is carried out based on the algorithm of above-mentioned Wood simultaneously.

[0246] Next, an example of operation when a certain signal is inputted is explained with reference to the timing chart of drawing 46 to the circuit of this drawing 45 .

[0247] When a signal (input wave) as shown in drawing 46 is now inputted into the regenerative circuit 80-80 of drawing 45 , a comparator circuit 80-14 operates as follows according to a table 2 and a table 3. However, initial value of yp and beta is set to yp=-2 and beta=-1, respectively.

[0248] < -- k=0: -- the time of input yk=y0=1.6;yp=-2;beta=-1 -- > -- since it is yk-yp=1.6-(-2) =3.6>2, an input corresponds to the condition pattern F of a table 3. That is, since it is upward emission (suitably henceforth divergence), according to a table 3, beta is updated to +1 of register 80-13a, p (time of day to which the emission before one came) is updated with a register 80-16, and it is referred to as p=k=0, and is referred to as yp(sampled value in time of day to which the emission before one came) =y0=1.6 by register 80-13b.

[0249] < -- k=1: -- the time of input yk=y1=0.2;yp=1.6;beta=+1;p=0 -- > -2 -- < -- since it is yk-yp=0.2-1.6=-1.4 <=0, an input corresponds to the condition pattern B of a table 2. That is, since it will be called parallel pass, beta of register 80-13a and 80-13b and yp presuppose that it remains as it is, choose the storage value k of a register 80-15 (= 1) by the selection circuitry 80-17, and write data (RAM data) 0 in the address k of RAM 80-18 (= 1) (the logic of the data in k= 1 is decoded as 0).

[0250] < -- k=2: -- the time of input yk=y2=-0.2;yp=1.6;beta=+1;p=0 -- > -2 -- < -- since it is yk-yp=-0.2-1.6=-1.8 <=0, an input corresponds to the condition pattern B of a table 2. That is, since it will be called parallel pass, beta of register 80-13a and 80-13b and yp presuppose that it remains as it is, choose the storage value k of a register 80-15 (= 2) by the selection circuitry 80-17, and write data 0 in the address k of RAM 80-18 (= 2) (the logic of the data in k= 2 is decoded as 0).

[0251] < -- k=3: -- the time of input yk=y3=2.0;yp=1.6;beta=+1;p=0 -- > -- since it is yk-yp=2.0-1.6=0.4>0, an input corresponds to the condition pattern C of a table 2. That is, since it is upward divergence, the former candidate yp becomes what (it was yp<yk) was beaten by the current value yk. Namely, in k= 0 (p= 0), although judged with upward emission (beta= +1) Since upward emission (beta= +1) came, it means being the parallel pass of the upward emissions last time this time (setting to k= 3) (in k= 0, supposing upward transition starts, in k= 3, pass will become discontinuity).

[0252] Then, the storage value p of a register 80-16 (= 0) is chosen by the selection circuitry 80-17, and data 0 is written in the address p of RAM 80-18 (= 0) (the logic of the data in k= 0 is decoded as 0). Moreover, beta is set to +1 of register 80-13a, and the storage value p of a register 80-16 is updated with the storage value k of a register 80-15, it is referred to as p=k=3, and the storage value yp of register 80-13b is further made into yp=y 3= 2.0.

[0253] < -- k=4: -- the time of input yk=y4=0.2;yp=2.0;beta=+1;p=3 -- > -2 -- < -- since it is yk-yp=0.2-2.0=-1.8 <=0, an input corresponds to the condition pattern B of a table 2. That is, since it will be called parallel pass, beta and yp remain as it is, choose k (= 4), and write data 0 in the address k of RAM 80-18 (= 4) (the logic of the data in k= 4 is decoded as 0).

[0254] < -- k=5: -- the time of input yk=y5=-0.4;yp=2.0;beta=+1;p=3 -- > -- since it is yk-yp=-0.4-2.0=-2.4 <=-2, an input corresponds to the condition pattern A of a table 2. That is, it means the former candidate being right since it is downward divergence (that is, it means that there had been upward transition among upward emissions in k= 3 (p= 3)). Therefore, data 1 is written in the address p of RAM 80-18 (= 3) (the data in k= 3 is decoded as logic 1). Moreover, beta is set to -1, and p is updated, and it is referred to as p=k=5, and is further referred to as yp=y5=-0.4.

[0255] < -- k=6: -- the time of input yk=y6=-0.2;yp=-0.4;beta=-1;p=5 -- > -- 0 -- < -- since it is yk-yp=-0.2-(-0.4) =0.2 <=+2, an input corresponds to the condition pattern E of a table 3. That is, since it will be called parallel pass, beta and yp remain as it is, choose k, and write data 0 in the address k of RAM 80-18 (= 6) (the data in k= 6 is decoded as logic 0).

[0256] < -- k=7: -- the time of input yk=y7=-2.0;yp=-0.4;beta=-1;p=5 -- > -- since it is yk-yp=-2.0-(-0.4)

=-1.6 <=0, an input corresponds to the condition pattern D of a table 3. That is, it means that the former candidate was beaten since it was downward divergence. That is, in k= 5 (p= 5), since it means that there had been downward not transition but parallel transition, data 0 is written in the address p of RAM 80-18 (= 5) (the data in k= 5 is decoded as logic 0). Moreover, beta is set to -1, and p is updated, and it is referred to as p=k=7, and is further referred to as yp=y7=-2.0.
[0257] < -- k=8: -- the time of input yk=y8=0.2;yp=-2.0;beta=-1;p=7 -- > -- yk-yp=0.2-(-2.0) = -- since is 2.2> +2, an input corresponds to the condition pattern F of a table 3. That is, since it will be called upward emission, it means front data being right. That is, in k= 7 (p= 7), since it means that downward transition had started, data 1 is written in the address p of RAM 80-18 (= 7) (the data in k= 7 is decoded as logic 1). Moreover, beta is set to +1 and it considers as yp=y 8= 0.2 (drawing 46).
[0258] Hereafter, similarly, the decode of data based on the algorithm of Wood is performed, and the decoded data is written in RAM 80-18 one by one.
[0259] RAM 80-18 is constituted by two or more memory cells D0 with the capacity of 1 bit thru/or Dn, an address decoder 80-31, and the write-in control line 80-32-0 thru/or 80-32-n arranged corresponding to each memory cell D0 thru/or Dn as shown in drawing 47 . Moreover, data (DATA) is supplied to all from the comparator circuit 80-14 shown in a memory cell D0 thru/or Dn at drawing 45 .
[0260] It writes in from the selection circuitry 80-17 shown in drawing 45 , and the address A0 thru/or An are supplied, and an address decoder 80-31 decodes the write-in address A0 thru/or An in an address decoder 80-31, and supplies a 1-bit signal each to it as each memory cell D0 thru/or a write-in signal over Dn. Thereby, the predetermined data (DATA) from a comparator circuit 80-14 is memorized by the predetermined memory cell.
[0261] Thus, after all the memory cells D0 thru/or the writing to Dn are completed, the data memorized by all the memory cells D0 thru/or Dn is outputted to coincidence in the synthetic circuit 80-2. Therefore, reading appearance of all the data will be carried out at this time.
[0262] As compared with the conventional technology (for example, technology indicated by the reference of above-mentioned Wood), that timing chart is shown like drawing 48 in this read-out timing. Drawing 48 (b) is a method in a regenerative circuit 80-80, if write-in enabling to RAM 80-18 becomes active, decoding of ID portion will be performed, after the writing of all data is completed, read-out enabling from RAM 80-18 becomes active, it shifts to a data area, and reading appearance of all the data is carried out to coincidence.
[0263] After writing ends this as compared with the conventional example shown in drawing 48 (a), a time delay until it finishes reading data from RAM 80-18 can be reduced sharply. In addition, it is easily realizable with the configuration of inputting a write-in control signal synchronizing with a clock, for example, using a 1-bit flip-flop as a memory cell D0 thru/or Dn.
[0264] therefore, decision whether if such a regenerative circuit 80-80 is applied to portions, such as ID record section 20-41H, a sector number, a track number, etc. will be desired things -- base -- it can process, without establishing most crevices between access processings (gap) in a part for ID portion and data division, since it can carry out now quickly.
[0265] For example, since a sector number, a track number, etc. are about several [at most] bytes, you may make it output all bits at once, they are at most several 10 bits, and are the range of practical use enough.
[0266] Moreover, all bits are not read from RAM 80-18 at once, for example, 8 bits is put together and you may make it read them. If it is made such, time amount after read-out from RAM 80-18 starts until it finishes reading can be set to one eighth, and the same effect as an above-mentioned case can be acquired also by this method.
[0267] By the way, the error detecting codes for the improvement in reliability (for example, a CRC (Cyclic Redundancy Check) sign etc.) are made by the sector number and the track number as [add / usually].
[0268] That is, it is a formula as generating-polynomial [of a CRC sign] G (x). G(x) =x16+x12+x5+1 ... (80-1)
When it ******, the division of the data for every predetermined bit length BL is done by generating-

polynomial G(x) =x16+x12+x5+1, and the remainder is added in the end of data (for example, sector ID etc.).
[0269] Then, in the shift register arithmetic circuit 80-3 of the regenerative circuit 80-80 of drawing 45 , using the updating instruction (UPDATE) and output data (DATA) from the change over signal (even/odd -1) from the change over circuit 80-1, and the processing circuit 80-10, and the updating instruction (UPDATE) and output data (DATA) from the processing circuit 80-20, if data is decoded (Viterbi decoding) simultaneously, it is made as [perform / a CRC operation].
[0270] To UPDATE and DATA which are hereafter outputted here from the comparator circuit 80-14 of the processing circuit 80-10 which processes an even number train sample In order that they may show that it is a signal corresponding to an even number train sample, while attaching and describing _even in the last of each character string To UPDATE and DATA which are outputted from the comparator circuit (circuit corresponding to the comparator circuit 80-14 of the processing circuit 80-10) of the processing circuit 80-20 which processes an odd number train sample In order that they may show that it is a signal corresponding to an odd number train sample, _odd is attached and described in the last of each character string.
[0271] When the highest degree of the generating polynomial in a CRC operation is set to J, namely, the shift register arithmetic circuit 80-3 As shown in drawing 49 , between J+2 flip-flop Da-1 thru/or DaJ, Db-1 or DbJ, Dc-1, DcJ or Dd-1 thru/or DdJ(s) by which vertical connection was made It is constituted as the parallel roads / a serial shift register by which four serial shift registers of a thru/or d sequence which connected J+1 selector Sa0 SaJ and Sb0 SbJ and Sc0 ScJ or Sd0 thru/or SdJ, respectively were connected to parallel.
[0272] Flip-flop Da-1 thru/or DaJ, Db-1 or DbJ, Dc-1 or DcJ and Dd-1 thru/or DdJ are the timing to which the clock which is not illustrated is supplied, and latches the data inputted. A selector Sa0 SaJ and Sb0 SbJ and Sc0 ScJ or Sd0 thru/or SdJ The change over signal from the change over circuit 80-1 (even/odd -1 (in drawing 49)) A bar (-) is attached and shown in odd. UPDATE_even from a certain processing circuit 80-10, DATA_even, And based on UPDATE_odd from the processing circuit 80-20, and DATA_odd, one is chosen and outputted from from among three signals inputted.
[0273] Here, the generating polynomial in a CRC operation is set to G (x) shown in the above-mentioned formula (80-1) in this example. Therefore, J is set to 16.
[0274] Furthermore, it sets to this shift register arithmetic circuit 80-3. Between flip-flops Da0, Db0, Dc0, or Dd0 and selectors Sa1, Sb1, Sc1, or Sd1 XOR gate 80-41a thru/or 80 to 41 d between flip-flops Da5, Db5, Dc5, or Dd5 and selectors Sa6, Sb6, Sc6, or Sd6 XOR gate 80-42a thru/or 80 to 42 d between flip-flops Da12, Db12, Dc12, or Dd12 and selectors Sa13, Sb13, Sc13, or Sd13 the XOR gate (not shown) is prepared, respectively and the output of flip-flops Da16, Db16, Dc16, or Dd16 is inputted into XOR gate 80-41a thru/or 80 to 41 d, respectively (fed back) -- it is made like.
[0275] Moreover, in this shift register arithmetic circuit 80-3, while the output of XOR gate 80-41a thru/or 80 to 41 d is made as [input / into XOR gate 80-42a thru/or 80 to 42 d /, respectively], it is made as [input / into the XOR gate between flip-flops Da12, Db12 Dc12, or Dd12 and selectors Sa13, Sb13, Sc13, or Sd13 /, respectively].
[0276] Therefore, each of four serial shift registers of a thru/or d sequence of the shift register arithmetic circuit 80-3 have the same composition as two flip-flops and the thing which prepared one selector at the preceding paragraph while preparing a selector in the CRC decoding circuit (not shown) which performs the CRC operation corresponding to the generating polynomial of a formula (80-1).
[0277] That is, when each of four serial shift registers of a thru/or d sequence of the shift register arithmetic circuit 80-3 are observed, in each serial shift register, the CRC operation based on generating-polynomial G (x) shown by the formula (80-1) will be performed.
[0278] Moreover, when the circuit which removed all the XOR gates is considered from the shift register arithmetic circuit 80-3, compounding an even number train sample and an odd number train sample based on UPDATE_even from the processing circuit 80-10, DATA_even and UPDATE_odd from the processing circuit 80-20, and DATA_odd, the circuit chooses the sequence of the serial shift register to survive, namely, chooses pass, and turns into a circuit which carries out Viterbi decoding of

the data.
[0279] That is, from the shift register arithmetic circuit 80-3, one by one, Viterbi decoding of the reproduced data will be carried out, and it will be outputted in the circuit which removed all the XOR gates (in the order of a sample).
[0280] According to an above-mentioned table 2 and an above-mentioned table 3, a change over signal (even/odd -1) is first inputted further into the shift register arithmetic circuit 80-3 constituted as mentioned above for UPDATE_even from the processing circuit 80-10 or 80-20, DATA_even or UPDATE_odd, and DATA_odd from the change over circuit 80-1 in the shift register arithmetic circuit 80-3, respectively.
[0281] And when the change over signal (even/odd -1) from the change over circuit 80-1 is logic 1, processing is performed based on UPDATE_even and DATA_even from the processing circuit 80-10 (when it is H level), When the change over signal (even/odd -1) from the change over circuit 80-1 is logic 0, processing is performed again based on UPDATE_odd and DATA_odd from the processing circuit 80-20 (when it is L level).
[0282] That is, in the shift register arithmetic circuit 80-3, it is the signal generation circuit which is not illustrated probably, and four signals (input_a, input_b, input_c, input_d) shown by the degree type are generated by UPDATE_even from the change over signal (even/odd -1) from the change over circuit 80-1, and the processing circuit 80-10 and DATA_even, and the list from UPDATE_odd from the processing circuit 80-20, and DATA_odd.
[0283]
input_a=(even/odd-1=1) *UPDATE_even+(even/odd-1=0) *UPDATE_odd input_b=(even/odd-1=1) *UPDATE_even input_c=(even/odd-1=0) *UPDATE_odd input_d=0, however * mean an AND and + means an OR. Furthermore, (even/odd-1=1) will become logic 1 if even/odd -1 is logic 1 (at the time of the timing of an even number train sample), and if even/odd -1 is logic 0 (at the time of the timing of an odd number train sample), it will become logic 0. Moreover, (even/odd-1=0) will become logic 0 if even/odd -1 is logic 1, and if even/odd -1 is logic 0, it will become logic 1.
[0284] Therefore, input_b serves as the same value as UPDATE (UPDATE_even) outputted from the effective processing circuit 80-10 only in the timing of an even number train sample, and input_c serves as the same value as UPDATE (UPDATE_odd) outputted from the effective processing circuit 80-20 only in the timing of an odd number train sample. Furthermore, in the timing of an even number train sample, input_a serves as the same value as UPDATE (UPDATE_even) outputted from the processing circuit 80-10, and serves as the same value as UPDATE (UPDATE_odd) outputted from the processing circuit 80-20 in the timing of an odd number train sample. input_d is always set to 0.
[0285] Four signal input_a, input_b, input_c, or input_d is inputted into flip-flop Da-1 of the first rank of the shift register arithmetic circuit 80-3 (drawing 49) thru/or Dd-1, respectively.
[0286] input_a, input_b and input_c which were inputted into flip-flop Da-1 thru/or Dd-1, respectively, or input_d is the timing of a clock, and a sequential latch is carried out through a selector at the flip-flop of the next step.
[0287] Here, in Selectors Saj, Sbj, Scj, or Sdj (j= 0, 1, ..., J (it is J= 16 as mentioned above in this example)), it is a signal from the preceding paragraph, and when the signal from the shift register of a sequence thru/or d sequence is made into in_a, in_b, in_c, or in_d, respectively, signal out_a, out_b and out_c according to a degree type, or out_d is outputted, respectively.
[0288]
out_a= *(even/odd-1=1) (UPDATE_even=1) *(DATA_even=0) *in_c + even/odd-1=1* (UPDATE_even=1) (* (DATA_even=0))-1*in_a + even/odd-1=0*(UPDATE_odd=1) *(DATA_odd=0) *in_b +(even/odd-1=0) *(UPDATE_odd=1) (* (DATA_odd=0))-1*in_a [0289]
out_b= *(even/odd-1=1) (UPDATE_even=1) *(DATA_even=0) *in_d+(even/odd-1=1) * (UPDATE_even=1) (* (DATA_even=0))-1*in_b + even/odd-1=0*(UPDATE_odd=1) *(DATA_odd=1) *in_a +(even/odd-1=0) *(UPDATE_odd=1) (* (DATA_odd=1))-1*in_b [0290]
out_c= *(even/odd-1=1) (UPDATE_even=1) *(DATA_even=1) *in_a + even/odd-1=1* (UPDATE_even=1) (* (DATA_even=1))-1*in_c + even/odd-1=0*(UPDATE_odd=1) *(DATA_odd=0)

*in_d +(even/odd-1=0) *(UPDATE_odd=1) (* (DATA_odd=0))-1*in_c [0291] out_d= *(even/odd-1=1) (UPDATE_even=1) *(DATA_even=1) *in_b + even/odd-1=1* (UPDATE_even=1) (* (DATA_even=1))-1*in_d + even/odd-1=0*(UPDATE_odd=1) *(DATA_odd=1) *in_c +(even/odd-1=0) *(UPDATE_odd=1) (* (DATA_odd=1))-1*in_d [0292] In addition, ()-1 means the negation in (). That is, ()-1 will become logic 0 if the logic in () is 1, and if the logic in () is 0, it will become logic 1.

[0293] From a top type, in this shift register arithmetic circuit 80-3, the sequence (right pass) of the serial shift register survived from UPDATE_odd from the processing circuit 80-20 and DATA_odd is chosen, the data latched to the flip-flop of the serial shift register of the selected sequence will be copied to the flip-flop of the serial shift register of other sequences, and Viterbi decoding will be carried out to UPDATE_even from the processing circuit 80-10 and DATA_even, and a list.

[0294] XOR of the flip-flop Da16 of the last stage of the serial shift register of a sequence thru/or d sequence thru/or the output of Dd16, and the output of a flip-flop Da0 thru/or Dd0 is taken by XOR gate 80-41a thru/or 80 to 41 d, and is inputted into coincidence in this shift register arithmetic circuit 80-3 at a selector Sa1 thru/or Sd1, respectively.

[0295] Furthermore, the output of XOR gate 80-41a thru/or 80 to 41 d While the flip-flop Da5 of the serial shift register of a sequence thru/or d sequence thru/or XOR with the output of Dd5 are taken by XOR gate 80-42a thru/or 80 to 42 d and is inputted into a selector Sa6 thru/or Sd6, respectively the flip-flop Da12 which the serial shift register of a sequence thru/or d sequence does not illustrate thru/or XOR with the output of Dd12 -- the flip-flop Da12 -- or -- ** -- It is taken by the XOR gate prepared between the selector Sa13 which is not illustrated thru/or Sd13, respectively, and is inputted into a selector Sa13 thru/or Sd13, respectively.

[0296] Therefore, in this shift register arithmetic circuit 80-3, the CRC operation based on the generating polynomial shown by the formula (80-1) will be performed.

[0297] By the way, in order to carry out Viterbi decoding of the partial response (1, 0, -1), the 2-bit sign for carrying out termination of the trellis diagram (it being hereafter indicated as a trellis) to the end of a block (bit string of the batch to decode) of the data (bit string) to decode is needed. As this 2-bit sign, it is a sign in front of PURIKODO, and, generally 11 is added to the end of a block.

[0298] The 2-bit sign for carrying out termination of this trellis For performing a CRC operation, are [therefore] unnecessary. In the shift register arithmetic circuit 80-3 Flip-flop Da-1 thru/or Dd-1 of the serial shift register of a sequence thru/or d sequence, the 2-bit data corresponding to the sign (11) for carrying out termination of the trellis added to the end of a block of data When latched to Da0 thru/or Dd0, respectively, the CRC result of an operation is evaluated based on 16 bits latched to either a flip-flop Dal Da16 and Db1 Db16 and Dc1 Dc16 and Dd1 thru/or Dd16.

[0299] That is, evaluation that there was no error in data when all of 16 bits latched to a flip-flop Dal Da16 and Db1 Db16 and Dc1 Dc16 and Dd1 or thru/or Dd(s)16 were 0 is made to the CRC result of an operation, and when one of bits is not 0 among the 16 bits, evaluation that the error was in data is made to the CRC result of an operation. [thru/or] [thru/or]

[0300] As mentioned above, it sets to the shift register arithmetic circuit 80-3. Between the flip-flops which constitute the serial shift register of each sequence which performs a Viterbi decoding method and by which vertical connection was made Since the XOR gate which computes the exclusive OR of the outputs of the flip-flop was arranged so that a CRC operation might be performed When the Jth is used as a generating polynomial of a CRC sign, the bit of the last of a block of the data from the magnetic-disk section 10-2 can obtain the CRC result of an operation within J-1 clock, after being inputted into the regenerative circuit 80-80 of drawing 45 .

[0301] That is, since Viterbi decoding and a CRC operation are performed to coincidence as shown in drawing 50 (b), a time lag required for decode and error detection of data can be decreased sharply.

[0302] Therefore, after carrying out Viterbi decoding of the data, when performing a CRC operation like the conventional method shown in drawing 50 (a), it compares. the gap between parts for ID portion of a magnetic disk, and data division (for example, the distance between ID record section 20-41H and data storage area 20-41D of drawing 2 --) Or distance between Gray code 20-71 and ID record section 20-

41H can be made small, and large capacity-ization of a magnetic disk can be attained.
[0303] In addition, in explanation of the above shift register arithmetic circuit 80-3, although what is shown in the generating polynomial of CRC by the formula (80-1) was used, it is not restricted to this and what is shown by other formulas can be used. In this case, what is necessary is to change the and the insertion point of XOR and just to constitute the shift register arithmetic circuit 80-3 while fluctuating the number of stages of a flip-flop corresponding to the generating polynomial to be used.
[0304] Furthermore, the above regenerative circuit 80-80 can be applied not only decoding of ID portion but when decoding the data (data currently recorded on data storage area 20-41D of drawing 2) of a data area.
[0305] Next, the point about the Records Department 10-9 of drawing 1 is explained.
[0306] Drawing 51 is the block diagram showing the example of a configuration of the whole magnetic disk drive. The clock mark for clock generation records data on the magnetic disk 90-1 (formatted as shown in drawing 2) recorded beforehand, and this magnetic disk drive is the so-called magnetic disk drive of the external synchronization method (sample servo system) which reproduces the data currently recorded.
[0307] And reproducing-head 90-11a for this magnetic disk drive to reproduce data from a magnetic disk 90-1, The playback amplifier 90-12 which amplifies the regenerative signal reproduced by reproducing-head 90-11a, The clock generation circuit 90-13 which generates a clock based on the regenerative signal equivalent to the clock mark of the magnetic disk 90-1 amplified with the playback amplifier 90-12, It has the data demodulator circuit 90-14 which reproduces data etc. from the regenerative signal from the playback amplifier 90-12 using the clock from the clock generation circuit 90-13.
[0308] Moreover, while carrying out counting of the clock from the clock generation circuit 90-13 and controlling the clock generation circuit 90-13 Data inputted as the timing generating circuit 90-15 which outputs the change over signal which switches a recording mode and a playback mode (in drawing 1) the record signal inputted into the Records Department 10-9 -- corresponding -- following source data -- saying -- with the record data generating circuit 90-16 changed into the data (henceforth record data) suitable for record It has the pulse delay circuit 90-30 delayed in the record data from the record data generating circuit 90-16. Recording head 90-11b for recording the record data furthermore delayed in the pulse delay circuit 90-30 on a magnetic disk 90-1, The record amplifier 90-18 which supplies the current based on the record data delayed in the pulse delay circuit 90-30 to recording head 90-11b, It has the time delay control circuit 90-20 which controls the amount of delay of the pulse delay circuit 90-30 based on the location (henceforth head positional information) in the direction of the diameter of a disk of recording head 90-11b from the data demodulator circuit 90-14.
[0309] As explained with reference to drawing 17 and drawing 18 , reproducing-head 90-11a In order to attain high density record, it consists of the so-called magneto-resistive effect form arm head (MR head). Recording head 90-11b consists of the usual magnetic head, in the transit direction, only distance L leaves reproducing-head 90-11a and recording head 90-11b, and they are arranged. Such reproducing-head 90-11a and recording head 90-11b constitute the so-called arm head 90-11 of a record playback discrete type.
[0310] On the other hand, with a spindle motor (100-21 of drawing 59), a fixed angular velocity To the magnetic disk 90-1 by which a rotation drive is carried out by (however, the so-called zone bit recording to which a clock frequency is changed for every zone) As shown in drawing 52 (a), between data segment 90-2 (data storage area 20-41D of drawing 2) which is the field which records the data of the recording track formed in the shape of a concentric circle For example, by removing a magnetic layer in part using technique, such as etching, the clock mark 90-3 (20-11 of drawing 2) which followed the radial for clock generation is formed beforehand. And direct-current magnetization is carried out in the one direction, and these clock marks 90-3 are formed 100-1000 divisors per round (the example mentioned above 840 places), in order to generate the clock of high degree of accuracy.
[0311] And reproducing-head 90-11a outputs the regenerative signal equivalent to the clock mark 90-3, and supplies these regenerative signals to the clock generation circuit 90-13 and the data demodulator

circuit 90-14 through the playback amplifier 90-12 while it outputs the regenerative signal equivalent to the data currently recorded on the data segment 90-2.
[0312] The clock generation circuit 90-13 has the PLL circuit 50-30 explained with reference to drawing 21 , and generates a clock based on the regenerative signal equivalent to the clock mark 90-3.
[0313] That is, if the clock mark 90-3 which carried out direct-current magnetization is reproduced to an one direction (right shown by the arrow head among drawing) as shown, for example in drawing 52 (a), as shown, for example in drawing 52 (b), the regenerative signal which has a solitary-wave form with the edge before and after the clock mark 90-3 will be reproduced. The timing generating circuit 90-15 carries out counting of the clock supplied from the clock generation circuit 90-13, predicts the apparition of the regenerative signal which is equivalent to the clock mark 90-3 based on the past hysteresis, and as shown, for example in drawing 52 (d), it generates the change over signal which switches a recording mode and a playback mode, while it supplies the clock gate signal which shows this period to the clock generation circuit 90-13.
[0314] As it considers that the solitary-wave form where it appears within the period out of which the clock gate signal has come is the clock mark of normal, for example, is shown in drawing 52 (c), the clock generation circuit 90-13 updates the phase of PLL so that the standup of a clock may synchronize with the peak of the solitary-wave form corresponding to a front edge, and generates the clock which carried out phase simulation to the clock mark 90-3.
[0315] And the data demodulator circuit 90-14 is the standup time of day (henceforth an existing [data] point phase) of the clock generated in the clock generation circuit 90-13 at the time of a playback mode. It sets, and discriminates from a regenerative signal (sampling level), and data is reproduced by getting over (it being Viterbi decoding as explained with reference to drawing 44 thru/or drawing 50). Moreover, this data demodulator circuit 90-14 reproduces the head positional information (for example, Gray code 20-71 of drawing 2 , a track number 20-41b1, 20-41b2, etc.) in the direction of the diameter of a disk of an arm head 90-11 based on a regenerative signal, and supplies this head positional information to the time delay control circuit 90-20.
[0316] On the other hand, in a recording mode, the record data generating circuit 90-16 changes source data into the record data which synchronized with the clock generated in the clock generation circuit 90-13 by the predetermined modulation (it mentioned above like PR modulation) suitable for record, and supplies the record data which synchronized with this clock to the pulse delay circuit 90-30 and the time delay control circuit 90-20.
[0317] The pulse delay circuit 90-30 on the basis of control of the time delay control circuit 90-20 While compensating the phase shift of the data recorded on the data segment 90-2 resulting from the distance L in the transit direction of reproducing-head 90-11a and recording head 90-11b so that it may mention later Record data is delayed so that a location gap (it is hereafter indicated as a nonlinear bit shift) of the flux reversal resulting from the pattern of record data may be compensated. The record amplifier 90-18 This delayed record data is amplified and the current based on record data is supplied to recording head 90-11b.
[0318] Specifically the time delay control circuit 90-20 For example, the adder 90-21 which adds a constant C3 to head positional information (track number) from the data demodulator circuit 90-14 as shown in drawing 53 , The multiplier 90-22 which carries out the multiplication of the constant C2 to the output of an adder 90-21, Delay machine 90-23a and 90-23b which are delayed by one clock, respectively in the record data from the record data generating circuit 90-16 and by which cascade connection was carried out, Exclusive "or" circuit (it is indicated as Following EXOR) 90-24a which calculates the exclusive OR of the record data from the record data generating circuit 90-16, and the record data delayed by delay machine 90-23a, EXOR90-24b which calculates the exclusive OR of the record data delayed by delay machine 90-23a, and the record data delayed by delay machine 90-23b, AND circuit 90-25 which calculates the AND of the output of EXOR90-24a, and the output of EXOR90-24b (it is indicated as Following AND), It consists of a change-over switch 90-26 which makes switch selection of a constant C1 and the constant 0 based on the output of AND 90-25, and an adder 90-27 adding the output of a change-over switch 90-26, and the output of a multiplier 90-22.

[0319] And this time delay control circuit 90-20 calculates the time difference between an existing [data] point phase and the time of day which should actually reverse record current based on the pattern of the head positional information supplied from the data demodulator circuit 90-14, and record data, and outputs a time delay indication signal.
[0320] That is, if an arm head 90-11 sets head positional information supplied from the data demodulator circuit 90-14 to track number N which carries out the current position, an adder 90-21 will add track number N and a constant C3 (the distance from a disk center to the most inner track is supported), and a multiplier 90-22 will carry out the multiplication of the constant C2 to this aggregate value. Consequently, from a multiplier 90-22, it is outputted as a time delay T1 which compensates the phase shift of the data with which the value which is proportional to distance (N+C3) from the disk center of an arm head 90-11 originates in the distance L in the transit direction of reproducing-head 90-11a and recording head 90-11b by the operation shown in the following (90-1) formula.
[0321]
T1=(N+C3) xC2 ... (90-1)
[0322] In addition, constants C2 and C3 are values with which are satisfied of T1=L/v, when speed in case an arm head 90-11 is located in the truck of a number N is set to v. If it puts in another way, T1 is equal to the time amount to which a magnetic disk moves only distance L.
[0323] On the other hand, delay machine 90-23a and 90-23b are delayed by one clock in record data, respectively, EXOR90-24a and 90-24b search for the 2-bit exclusive OR adjoined of the triplets which record data follows, respectively, and AND 90-25 searches for the AND of each output of EXOR90-24a and 90-24b. Consequently, the pattern with which a nonlinear bit shift (the length of a magnetization field stops being proportional to the supply time amount of drive current) tends to happen from AND 90-25, Namely, when record data has the pattern (010 or 101) with which 2 bits of flux reversal continue continuously (the condition that different logic (1 or 0) adjoins continues continuously twice), For example, the continuation flux reversal detecting signal used as H level is outputted, and when it is others, the signal of L level is outputted.
[0324] And a change-over switch 90-26 supplies the constant which chose the constant C1, and chose and chose the constant 0 at the time of L level to an adder 90-27 based on this continuation flux reversal detecting signal at the time of H level. Consequently, from a change-over switch 90-26, a constant C1 is outputted as a time delay T2 which compensates a nonlinear bit shift to the pattern which produces flux reversal continuously, i.e., the pattern which a nonlinear bit shift generates, (as mentioned above here 010 a certain ** 101).
[0325] An adder 90-27 adds a time delay T1 and a time delay T2, and supplies them to the pulse delay circuit 90-30 by making this aggregate value (T1+T2) into a time delay indication signal.
[0326] As the time delay has become controllable from the exterior, for example, the pulse delay circuit 90-30 is shown in drawing 52 (h) While only the time amount (T1+T2) directed with the time delay indication signal supplied from the time delay control circuit 90-20 is delayed in the record data (drawing 52 (g)) supplied from the record data generating circuit 90-16 For example, as shown in drawing 52 (f), the change over signal (drawing 52 (d)) supplied from the timing generating circuit 90-15 is delayed, and a write enable signal (low active signal) is generated.
[0327] As the pulse delay circuit 90-30 is shown in drawing 54 , specifically The adjustable delay circuit 90-31 which has the time delay of a length of one or less clock, The time delay indication signal from the sequential circuit 90-32 which has the time delay of 1 clock unit, and the time delay control circuit 90-20 The time delay of 1 clock unit, It divides into the time delay of the fraction which remains, and consists of time delay distribution circuits 33 supplied to a sequential circuit 90-32 and the adjustable delay circuit 90-31, respectively.
[0328] And the time delay distribution circuit 33 divides the time delay indication signal supplied from the time delay control circuit 90-20 into the time delay of 1 clock unit, and the time delay of the fraction which remains, supplies the time delay of 1 clock unit to a sequential circuit 90-32, and supplies a fractional time delay to the adjustable delay circuit 90-31.
[0329] A sequential circuit 90-32 is a delay circuit which operates synchronizing with a clock, and

builds in counting circuit 90-32a which carries out counting of the clock to the interior. When this counting circuit 90-32a carries out counting of the time delay part clock of 1 clock unit, only the time delay of 1 clock unit generates the middle output of the write enable signal with which timing shifted, and record data based on a change over signal and record data.
[0330] On the other hand, the adjustable delay circuit 90-31 performs delay within 1 clock time amount according to directions of a fractional time delay, adds still more precise delay to the middle output of record data, and outputs the record data after delay.
[0331] And this pulse delay circuit 90-30 supplies a write enable signal and the record data after delay to the record amplifier 90-18. That is, a circuit scale is large by considering as such a configuration, and power consumption can be reduced while making the whole circuit scale small, since the number of the adjustable delay circuits 90-31 where a high time amount precision is demanded is one, and it ends and the maximum time delay should just have the length for one clock.
[0332] The record amplifier 90-18 controls energization/cutoff of record current according to the write enable signal supplied from the pulse delay circuit 90-30, and reverses record current according to the record data delayed in the pulse delay circuit 90-30.
[0333] In this way, the change over signal outputted from the timing generating circuit 90-15 and the record data outputted from the record data generating circuit 90-16 synchronize with the clock (drawing 52 (c)) generated in the clock generation circuit 90-13, as shown in above-mentioned drawing 52 (d) and this drawing (g). That is, these signals support the location on data segment 90-2 seen from reproducing-head 90-11a, as shown in above-mentioned drawing 52 (a).
[0334] By the way, if relative velocity of an arm head 90-11 and a disk is set to v, time difference T1=L/v exists between the data segment 90-2 seen from reproducing-head 90-11a shown in drawing 52 (a), and the data segment 90-2 seen from recording head 90-11b as shown in drawing 52 (e). As shown in above-mentioned drawing 52 (f) and this drawing (h), while the pulse delay circuit 90-30 generates the write enable signal corresponding to the location on data segment 90-2 as which only this time difference T1 was delayed, and regarded a change over signal and record data from recording head 90-11b, and the record data after delay, respectively, to record data, only time amount T2 which compensates an above-mentioned nonlinear bit shift is delayed further.
[0335] Consequently, while compensating the phase shift of the data recorded on the data segment 90-2 resulting from the distance L in the transit direction of reproducing-head 90-11a and recording head 90-11b, a location gap (nonlinear bit shift) of the flux reversal resulting from the pattern of record data can be compensated, and data can be recorded on the right location on a data segment 90-2.
[0336] If it puts in another way, by controlling energization initiation of record current, end time, and reversal time of day of record current by the pulse delay circuit 90-30, it cannot be based on the pattern of the location in the direction of the diameter of a disk of an arm head 90-11, or data, but data can be recorded on the right location on a data segment 90-2. Therefore, standup time of day of the clock generated in the playback mode in the clock generation circuit 90-13 (existing [data] point phase) By setting and discriminating from a regenerative signal, the regenerative signal will be referred to in the data's currently recorded on data segment 90-'s2 existence location, and errorless data playback can be performed.
[0337] Next, other concrete circuitry of the time delay control circuit 90-20 shown in drawing 51 is explained with reference to drawing 55 . Delay machine 90-41a and 90-41b for which the time delay control circuit 90-20 of drawing 55 is delayed by one clock, respectively in the record data from the record data generating circuit 90-16 and by which cascade connection was carried out, Head positional information from the record data delayed by delay machine 90-41a and 90-41b and the data demodulator circuit 90-14 is made into the read-out address, and a time delay (T1+T2) consists of memory 90-42 memorized beforehand.
[0338] And the record data delayed by delay machine 90-41a and 90-41b is supplied to memory 90-42 as the 11-bit read-out address with the track number which consists of 8 bits.
[0339] Memory 90-42 has memorized the time delay according to a track number and the combination of the pattern of data, and outputs a time delay indication signal according to the read-out address.

[0340] That is, in memory 90-42, about a track number and all the combination of the pattern of record data, by memorizing the fitness time delay, for example [to the location in the direction of the diameter of a disk of an arm head 90-11], a nonlinear time delay can be outputted and a fine time delay can be controlled.
[0341] Moreover, as a rough time delay is computed in the time delay control circuit of drawing 53 and the remaining top kana timing is performed in the time delay control circuit of drawing 55 combining the time delay control circuit shown in this drawing 55 , and the time delay control circuit shown in above-mentioned drawing 53 , you may make it reduce the capacity of memory 90-42.
[0342] Next, as shown in the magnetic disk 90-1 of drawing 51 at drawing 56 Between the data segments 90-52 which are the fields which record the data of the recording track formed in the shape of a concentric circle, for example, by removing a magnetic layer in part using technique, such as etching The clock mark 90-53 (clock mark 20-11 of drawing 2) which followed the radial for clock generation, Reproducing-head 90-11a and the timing compensation pattern 90-54 of width of face equal to the gap L of recording head 90-11b of predetermined width of face are formed beforehand. When the direct-current magnetization of the clock mark 90-53 and the timing compensation pattern 90-54 is carried out in the one direction (direction shown by the arrow head in drawing 58 (a)), the magnetic disk drive of drawing 51 The timing measurement circuit 90-60 which measures the time difference T1 mentioned above instead of the time delay control circuit 90-20 can be formed, and as shown in drawing 57 , it can constitute.
[0343] In addition, explanation is omitted about the circuit shown in drawing 51 , and the circuit which has the same function.
[0344] As shown in drawing 58 (c), the timing generating circuit 90-15 generates the timing measurement window signal which shows the period when counting of the clock is carried out at and reproducing-head 90-11a is scanning the timing compensation pattern 90-54, and supplies this timing measurement window signal to the timing measurement circuit 90-60.
[0345] As shown in drawing 58 (b), in the period of H level, a timing measurement window signal measures the time amount T1 between the peaks of two solitary-wave forms reproduced with the edge before and behind the timing compensation pattern 90-54, and supplies the timing measurement circuit 90-60 to the pulse delay circuit 90-30 by making time amount T1 into a time delay indication signal.
[0346] Here, the width of face L of the timing compensation pattern 90-54 is not based on the radius of a disk, but since it is fixed, the time difference to which the edge before that and a next edge pass reproducing-head 90-11a is always equal [the width of face] to the pass time difference T1 of reproducing-head 90-11a and recording head 90-11b.
[0347] That is, the time difference between the peaks of the regenerative signal equivalent to the timing compensation pattern 90-54 is the time delay T1 which should be supplied to the pulse delay circuit 90-30.
[0348] Therefore, a time delay T1 can be directly found from the timing compensation pattern 90-54 beforehand formed on the magnetic disk 90-1, the arithmetic circuit of the adder 90-21 shown in drawing 53 and multiplier 90-22 grade and the memory 90-42 shown in drawing 55 become unnecessary, and the cost of a magnetic disk drive can be reduced.
[0349] In addition, in fact, although it simplified to the disk radial linearly and each field was shown in it at drawing 56 , as shown in drawing 6 and drawing 7 , it is formed along with the rotation locus of the magnetic head.
[0350] As mentioned above, since the phase shift of the data recorded on the magnetic disk 90-1 which is delayed in record data based on the regenerative signal equivalent to the timing compensation pattern of predetermined width of face, and originates in the distance in the transit direction of reproducing-head 90-11a and recording head 90-11b was compensated, data playback which can record data now on a right location, consequently is errorless can be performed.
[0351] In addition, record playback not only of the sector number and track number of ID record section 20-41H of drawing 2 but the original data on data storage area 20-41D can be carried out by PRML as mentioned above.

[0352] Next, the point about the housing section 10-10 of drawing 1 is explained.
[0353] The hole 100-2 for attaching a spindle motor 100-21 is formed in the plane section of the bottom housing 100-1 (40-51 of drawing 19) constituted by the aluminum alloy etc. When a level difference is formed in the periphery of this hole 100-2 and a motor 100-21 is attached there, the packing 100-3 which consists of rubber etc. is arranged so that air may not leak from that installation section. Moreover, a shaft 100-4 is implanted in the bottom housing 100-1, and it is made as [equip / with the ball bearing 100-6 (40-55 of drawing 19) attached in the arm 100-5 (40-53 of drawing 19)].
[0354] It is made by the end of an arm 100-5 as [attach / a voice coil 100-7 (40-63 of drawing 19) is attached, and / in the other end / the slider (40-57 of drawing 19) which has the magnetic head]. It is made by a coil 100-7 and the magnetic head as [supply / from a flexible printed circuit board 100-8 / a signal]. IC 100-9 which performs signal processing is arranged at the flexible printed circuit board 100-8. Moreover, the edge of a printed circuit board 100-8 is made as [draw / by the exterior of a housing] so that it may mention later. A magnet 100-11 and 100-12 (62 and 61 of drawing 19) are attached in the bottom housing 100-1 so that a coil 100-7 may be arranged in the meantime. The voice coil motor (50-5 of drawing 21) is constituted by this voice coil 100-9 and magnet 100-11,100-12.
[0355] The magnetic disk 23 (40-52 [of drawing 19], 50-1A [of drawing 21], 50-1B) of two sheets is attached in a motor 100-21 free [rotation]. The edge is drawn by the exterior of a housing and the flexible printed circuit board 100-22 is made as [supply / from the exterior / to a motor 100-21 / a control signal].
[0356] The top housing 100-31 has a step 100-32 and 100-33 in the lateral portion by the side of drawing Nakamigi, and is made as [derive / a flexible printed circuit board 100-8 and the edge of 100-22 /, respectively / from this step 100-32 and 100-33 / outside]. Moreover, the spiracle 100-34 is formed in the upper surface (plane section) of the top housing 100-31. Although the filter and the valve are attached in that interior and air advances into this spiracle 100-34, water is made as [pass].
[0357] Drawing 60 and drawing 61 show typically the assembly condition of the bottom housing 100-1 and the top housing 100-31. Although the bottom housing 100-1 is constituted by the tabular member as shown in these drawings, the top housing 100-31 is formed in box-like of plane section 100-31a and lateral portion 100-31b. And packing 100-41 is inserted among both, and it is made as [advance / after assembly / near the flexible printed circuit board 100-22 (or flexible printed circuit board 100-8) drawn to the exterior of a housing / into the interior of the sealed housing / air].
[0358] That is, in the condition of having been sealed after assembling the bottom housing 100-1 and the top housing 100-31, the space inside a housing is intercepted with the exterior, and through the spiracle 100-34 with which plane section 100-31a is equipped, air is made as circulation is possible, and it is **********. Thereby, it is prevented that dust, dust, etc. advance into the interior. Moreover, in order that air may go in and out through a spiracle 100-34, an internal atmospheric pressure is adjusted so that it may be mostly in agreement with an external atmospheric pressure.
[0359] The length of the bottom housing 100-1 and the top housing 100-31 is set to 100mm, and width of face is set to 70mm. And the height in the condition of having combined both is set to 12.7mm, when the number of magnetic disks 100-23 is two and it is 15.0mm and one sheet.
[0360] In addition, although the bottom housing 100-1 was constituted in tabular in this example and the top housing 100-31 was formed in box-like, as shown in drawing 62 and drawing 63 , it is also possible to form the bottom housing 100-1 in box-like by plane section 100-1a and lateral portion 100-1b, and to form the top housing 100-31 in tabular (plane section 100-31c).
[0361] The feature of the housing shown in these drawings is in the point that the hole is not formed in plane section 100-31a other than spiracle 100-34. In order to make this feature easier to understand, the configuration of the former top housing 100-31 is shown in drawing 64 . As shown in this drawing, the hole 100-51,100-52 and the crevice 100-53 are formed in the former top housing 100-31. Although a crevice 100-53 is a hollow for sticking a label, a hole 100-51 is a hole for inserting the arm head for servo lights.
[0362] That is, in the conventional magnetic disk drive, if servo signals, such as an encoder, are recorded before building a magnetic disk into a housing, it will originate in deformation or an

installation error by the pressure at the time of an assembly etc., eccentricity will occur, and the record location of the position signal in the condition of having recorded the servo signal will not necessarily correspond correctly with the location in the case of actually recording data. It becomes impossible for this reason, to apply an exact servo. Then, after building a magnetic disk into a housing, he is trying to record a servo signal on a magnetic disk in conventional equipment.
[0363] That is, in order to record a servo signal on the magnetic disk built into the housing, the magnetic head for record (arm head for servo lights) is inserted from a hole 100-51. And a servo signal is recorded on a magnetic disk by the arm head.
[0364] Moreover, a mirror is irradiated from a hole 100-52 at the arm included in the interior of a housing, the laser beam of a laser length measuring machine is irradiated at installation and this mirror, and that location is measured to a precision. And the location of an arm is moved to radial [of a magnetic disk] one by one, measuring the location of an arm correctly with this laser length measuring machine. And servo data (encoder) is recorded on a predetermined truck.
[0365] For example, although servo data is recorded on one truck of the outermost periphery, one fourth of the width-of-face [every] servo data of a truck is recorded, the location can be shifted one by one every [4 / 1/] in the direction perpendicular to a truck, and the servo signal to one truck can be recorded by four rotations. Thus, the rotary encoder is recorded on the outermost periphery truck of a magnetic disk.
[0366] Thus, after recording servo data on a magnetic disk, a hole 100-51 and 100-52 are blockaded by the predetermined member, and a housing is sealed.
[0367] However, as explained with reference to drawing 2 thru/or drawing 8 , stamp formation is carried out beforehand and a truck and servo data are recorded on the location physically formed as a record section of dedication in distinction from other fields by the magnetic disk of this invention. Therefore, the record location (shaping location) can apply the technology which controls minutely the exposure location of the laser beam at the time of disk shaping, and can adjust it very correctly. Then, what is necessary will be to take into consideration only the eccentricity resulting from an installation error in this example.
[0368] According to this example, as explained with reference to drawing 34 and drawing 35 , as an offset signal is added to a tracking error signal by feedforward control, it is made also to eccentricity that exact control is possible. Consequently, though stamp formation of the clock mark 20-11 besides servo patterns, such as the home index 100-73, the unique pattern 20-72, Gray code 20-71, wobble DOMAKU 20-12, and 20-13, sector number 20-41a, a track number 20-41b1, 20-41b2, etc. is carried out beforehand at the magnetic disk and this is incorporated in a housing afterwards, exact record playback is attained. Consequently, in this invention, it is not necessary to form the hole for servo data logging in the housing.
[0369] Thus, since it is not necessary to make a hole in a housing, mechanical rigidity can be made to increase that what is necessary is just to form a housing as the simple box or board of height of homogeneity. This becomes possible to a presser foot to position an arm head for mechanical resonance to high degree of accuracy to a magnetic disk.
[0370] Furthermore, about a magnetic disk drive, since the hole has opened conventionally, although the yes-no decision had to be tested in the clean room, since there is no hole according to this invention, handling [clean room] of after assembly becomes unnecessary.
[0371] In addition, when a spindle motor 100-21 is further made into a thin shape, the hole 100-2 for the attachment can be omitted.
[0372] Since it is such, and according to this equipment manufacture becomes easy and the time amount taken to complete one equipment also becomes short, low cost-ization is attained.
[0373]
[Effect of the Invention] Since it was made to carry out stamp formation by making a guard band into a crevice to the truck like the above according to the magnetic disk drive according to claim 1, it becomes unnecessary to make a guard band large for cross talk mitigation, a track pitch is narrowed, and it becomes possible to increase storage capacity. Moreover, since it was made to carry out stamp

formation of the mark for tracking, a track number distinguishing mark, or the clock mark with irregularity along with the rotation locus of the magnetic head, exact access is attained when a track pitch is narrowed.
[0374] Since according to the magnetic disk drive according to claim 2 the variation corresponding to the eccentricity of disk-like data medium is measured and record or playback actuation was controlled corresponding to the measurement result, the mark for tracking, a track number distinguishing mark, or a clock mark becomes record of exact data, or reproducible irrespective of eccentricity also in the magnetic disk drive which incorporated disk-like data medium currently recorded beforehand to the case afterwards.
[0375] It becomes controllable [an exact disk-like record medium], securing storage capacity according to the magnetic disk drive according to claim 3, since the number of the groups of the mark for tracking, a track number distinguishing mark, and a clock mark was made or less into 1000 per round.
[0376] Securing storage capacity, since the rate of occupying to 1 round of a control signal record section was made into 40% or less according to the magnetic disk drive according to claim 4, ****** of the magnetic head by the mark signal by which stamp formation was carried out is minimized, and it becomes possible to carry out record playback of the data correctly.
[0377] Since according to the magnetic disk drive according to claim 5 resin or glass constituted the substrate of disk-like data medium, the lightweight-ized equipment can be realized and profile irregularity can be made good, distance of the magnetic head and disk-like data medium is made small, and it becomes possible to realize small equipment.
[0378] According to the magnetic disk drive according to claim 6, since a recording head and the reproducing head were separated, it becomes possible to carry out record playback of the data at a high speed.
[0379] Since the 1st mark was formed in the location which shifted from the truck to radial according to the magnetic disk drive according to claim 7, even if it separates a recording head and the reproducing head, it becomes possible to carry out tracking control of the recording head correctly on a truck at the time of record.
[0380] Since two or more marks were prepared, even if one side has a drop out etc. according to the magnetic disk drive according to claim 8, it can access on the basis of another side, and safety can be raised.
[0381] According to the magnetic disk drive according to claim 9, since the location variation of the mark for tracking or a track number distinguishing mark or the time amount variation of a clock mark was detected, it becomes possible to detect the eccentricity of disk-like data medium correctly.
[0382] Since the eccentric controlled variable which amends the location gap resulting from the eccentricity of the magnetic head from the mark for tracking, a track number distinguishing mark, or a clock mark was calculated according to the magnetic disk drive according to claim 10, it becomes possible to amend the location gap resulting from eccentricity correctly.
[0383] Positive tracking control becomes possible, without raising the servo gain of the whole tracking control, since according to the magnetic disk drive according to claim 11 the eccentric controlled variable calculated and obtained is memorized and it was made to carry out tracking control of the magnetic head corresponding to the memorized eccentric controlled variable.
[0384] Since according to the magnetic disk drive according to claim 12 time amount variation is measured from a clock mark and the time-axis of a clock signal was amended corresponding to this, the jitter resulting from eccentricity etc. can be controlled.
[0385] According to the magnetic disk drive according to claim 13, since it was made to perform Viterbi decoding and a CRC operation to coincidence, quick processing of a regenerative signal is attained.
[0386] According to the magnetic disk drive according to claim 14, since record data was made to be delayed corresponding to a playback clock, the phase shift resulting from the distance of the reproducing head and a recording head and a nonlinear bit shift can be amended, and record data can be recorded on an exact location.
[0387] According to the magnetic disk drive according to claim 15, since record actuation was

controlled corresponding to the location gap, malfunction when an unusual shock etc. is added can be controlled.
[0388] According to the magnetic disk drive according to claim 16, since only the spiracle was prepared in the case, the time amount which manufacture takes becomes short and can make cost cheap.
[0389] According to the magnetic disk drive according to claim 17 to 19, since it was made to make the diameter of disk-like data medium into 2.5 inches, 1.8 inches, or 1.3 inches, small and lightweight equipment is realizable.
[0390] Since according to the manufacture method of a magnetic disk drive according to claim 20 disk-like data medium was assembled to the case after stamp-forming the mark for tracking, the track number distinguishing mark, and the clock mark and recording them, equipment can be completed quickly and cost can be made cheap.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the configuration of the whole magnetic disk drive of this invention.
[Drawing 2] It is drawing explaining the format of the servo data storage area of the magnetic disk of this invention, and a data storage area.
[Drawing 3] It is drawing explaining the format of the servo data storage area where the unique pattern of the magnetic disk of this invention exists.
[Drawing 4] It is drawing explaining the format of the servo data storage area where the home index of the magnetic disk of this invention exists.
[Drawing 5] It is drawing explaining the unique pattern of the magnetic disk of this invention, and the format of the servo data storage area where a home index does not exist.
[Drawing 6] It is drawing explaining the relation of the rotation locus of the magnetic head of the servo data storage area of the magnetic disk of this invention, and a data storage area.
[Drawing 7] It is drawing explaining the configuration of the plane of the servo data storage area of the magnetic disk of this invention.
[Drawing 8] It is drawing explaining the cross-section configuration of the magnetic disk of this invention.
[Drawing 9] It is drawing explaining the stamp pattern of the irregularity on the magnetic disk of this invention.
[Drawing 10] It is drawing explaining how to magnetize the magnetic disk which has the irregularity of this invention.
[Drawing 11] It is a cross section explaining the more detailed cross-section configuration of the magnetic disk of this invention.
[Drawing 12] It is a plan explaining the outline of the data storage area of this invention, and a servo data storage area.
[Drawing 13] It is drawing explaining the relation between the slider of this invention, and a magnetic disk.
[Drawing 14] It is drawing explaining change of a flying height [/ near the crevice on the magnetic disk of the slider of this invention].
[Drawing 15] It is drawing explaining the rate of the data storage area used for the simulation of slider flying-height change of this invention, and a servo data storage area.
[Drawing 16] It is drawing explaining signs that the flying height of a slider changes the segment period of this invention.
[Drawing 17] It is drawing showing the configuration of the transverse plane of the magnetic head of this invention.
[Drawing 18] It is a cross section explaining the configuration of the cross section of the magnetic head of this invention.
[Drawing 19] It is a perspective diagram explaining the configuration of the arm of this invention.

[Drawing 20] It is a cross section explaining the configuration of the ball bearing of drawing 19 .
[Drawing 21] It is the block diagram showing the configuration of the circuit which amends the time-base error of the clock signal of this invention.
[Drawing 22] It is drawing explaining actuation of eccentricity.
[Drawing 23] It is property drawing explaining change of the phase of the PLL clock to a disk clock.
[Drawing 24] It is the block diagram showing the configuration of other circuits which amend the time-base error of the clock of this invention.
[Drawing 25] It is drawing explaining the relation between a clock mark and eccentricity.
[Drawing 26] It is the block diagram showing the configuration of the eccentricity test section 50-25 of drawing 21 .
[Drawing 27] It is drawing explaining the time interval of a clock mark regenerative signal.
[Drawing 28] It is drawing explaining change of clock time interval counted value.
[Drawing 29] It is drawing explaining eccentricity.
[Drawing 30] It is the block diagram showing other examples of a configuration of the eccentricity test section 50-25 of drawing 21 .
[Drawing 31] In the example of drawing 30 , it is drawing explaining the time interval of a clock mark regenerative signal.
[Drawing 32] In the example of drawing 30 , it is drawing explaining change of a clock time interval.
[Drawing 33] In the example of drawing 30 , it is drawing explaining eccentricity.
[Drawing 34] It is the block diagram showing the example of a configuration of the tracking servo circuit of this invention.
[Drawing 35] It is drawing explaining the transfer characteristics of the example of drawing 34 .
[Drawing 36] It is drawing explaining the disturbance oppression gain by the closed loop in the example of drawing 34 .
[Drawing 37] It is drawing explaining the appearance disturbance oppression gain in the example of drawing 34 .
[Drawing 38] It is the block diagram showing the configuration of the circuit which judges the off-track of this invention.
[Drawing 39] It is a flow chart explaining actuation of the example of drawing 38 .
[Drawing 40] It is drawing explaining the response waveform at the time of impressing the shock of 10G or 100G.
[Drawing 41] It is the enlarged view of the response waveform immediately after carrying out the seal of approval of the shock of 100G.
[Drawing 42] It is drawing explaining the migration locus of the arm head at the time of impressing the shock of 100G.
[Drawing 43] It is drawing explaining the response waveform at the time of impressing the shock of 100G with a noise.
[Drawing 44] It is drawing explaining the condition of the pass in Viterbi decoding.
[Drawing 45] It is a block diagram explaining the example of a configuration of the Viterbi decoder circuit.
[Drawing 46] It is a timing chart explaining actuation of the example of drawing 45 .
[Drawing 47] It is a block diagram explaining the example of a configuration of RAM 80-18 of drawing 45 .
[Drawing 48] It is a timing chart explaining actuation of the example of drawing 47 .
[Drawing 49] It is a block diagram explaining the configuration of the circuit in the case of performing the Viterbi decoding and the CRC operation of this invention to coincidence.
[Drawing 50] It is a timing chart explaining actuation of the example of drawing 49 .
[Drawing 51] It is the block diagram showing the configuration of the record circuit of this invention.
[Drawing 52] It is a timing chart explaining actuation of the example of drawing 51 .
[Drawing 53] It is the block diagram showing the configuration of the time delay control circuit 90-20 of drawing 51 .

[Drawing 54] It is the block diagram showing the configuration of the pulse delay circuit 90-30 of drawing 51 .
[Drawing 55] It is the block diagram showing other examples of a configuration of the time delay control circuit 90-20 of drawing 51 .
[Drawing 56] It is drawing showing the record format of the magnetic disk which applied this invention.

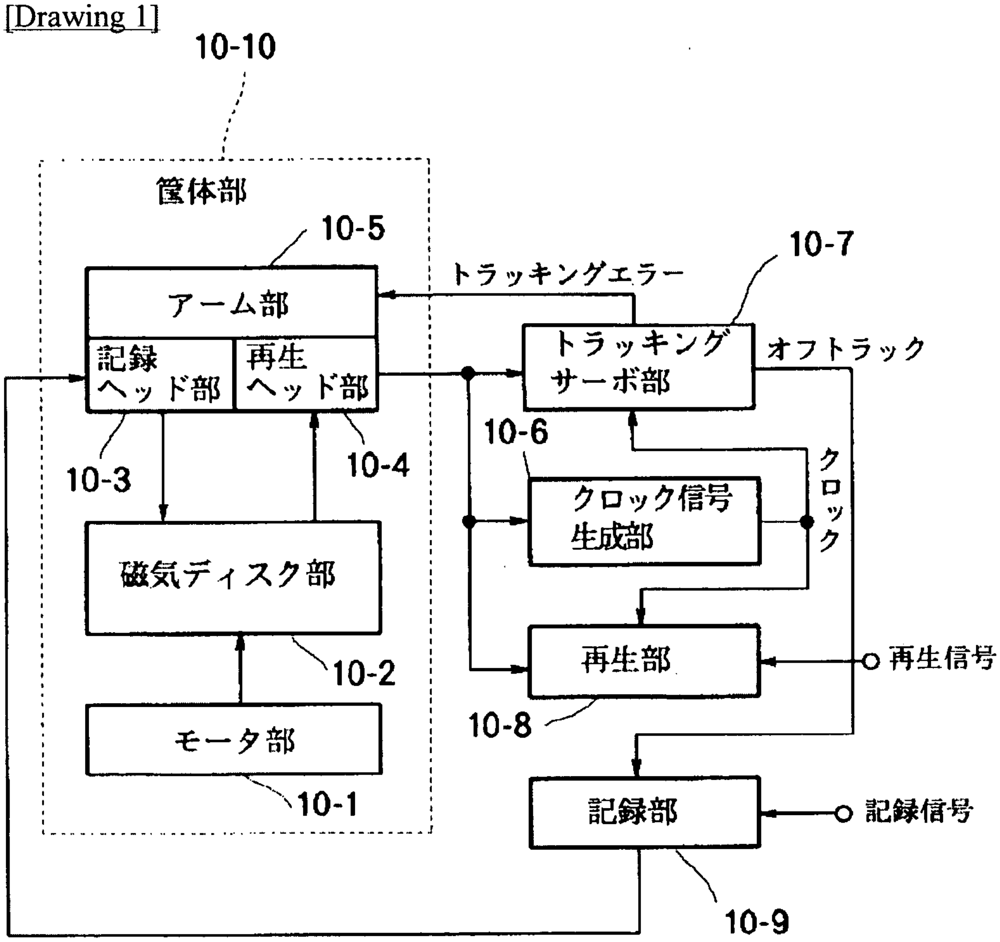
[Drawing 57] It is the block diagram showing the configuration of the record circuit of this invention in the case of using the example of drawing 56 .
[Drawing 58] It is a timing chart explaining actuation of the example of drawing 57 .
[Drawing 59] It is the decomposition perspective diagram showing the assembly condition of the case of this invention, and internal components.
[Drawing 60] It is the perspective diagram showing the configuration of the case of this invention.
[Drawing 61] It is the cross section showing the cross-section configuration of the example of drawing 60 .
[Drawing 62] It is the perspective diagram showing the configuration of other examples of the case of this invention.
[Drawing 63] It is the cross section showing the cross-section configuration of the example of drawing 62 .
[Drawing 64] It is the perspective diagram showing the configuration of the conventional case.
[Description of Notations]
10-1 Motor Section
10-2 Magnetic-Disk Section
10-3 Recording Head Section
10-4 Reproducing-Head Section
10-5 Arm Section
10-6 Clock Signal Generation Section
10-7 Tracking Servo Section
10-8 Playback Section
10-9 Records Department
10-10 Case Section
20-10 Truck
20-11 Clock Mark
20-12, 20-12-1, 20-12-2, 20-13, 20-13-1, 20-13-2 Wobble DOMAKU
20-20 Guard Band
20-30 Reproducing Head
20-31 Recording Head
20-40 Servo Data Storage Area
20-41, 20-41D Data storage area
20-41H ID record section
20-71 Gray Code
20-72 Unique Pattern
20-73 Home Index

[Translation done.]

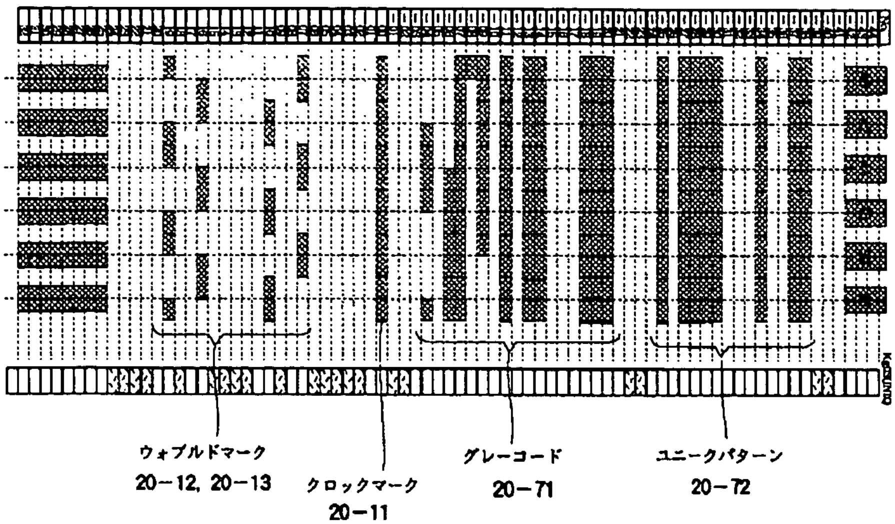
* NOTICES *

DRAWINGS

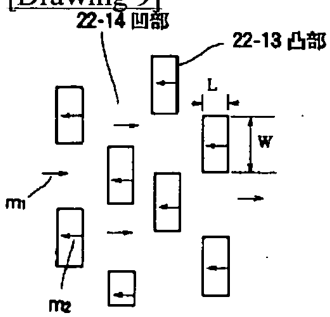
[Drawing 1]



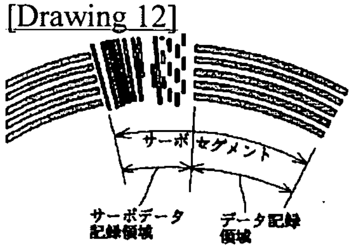
[Drawing 3]



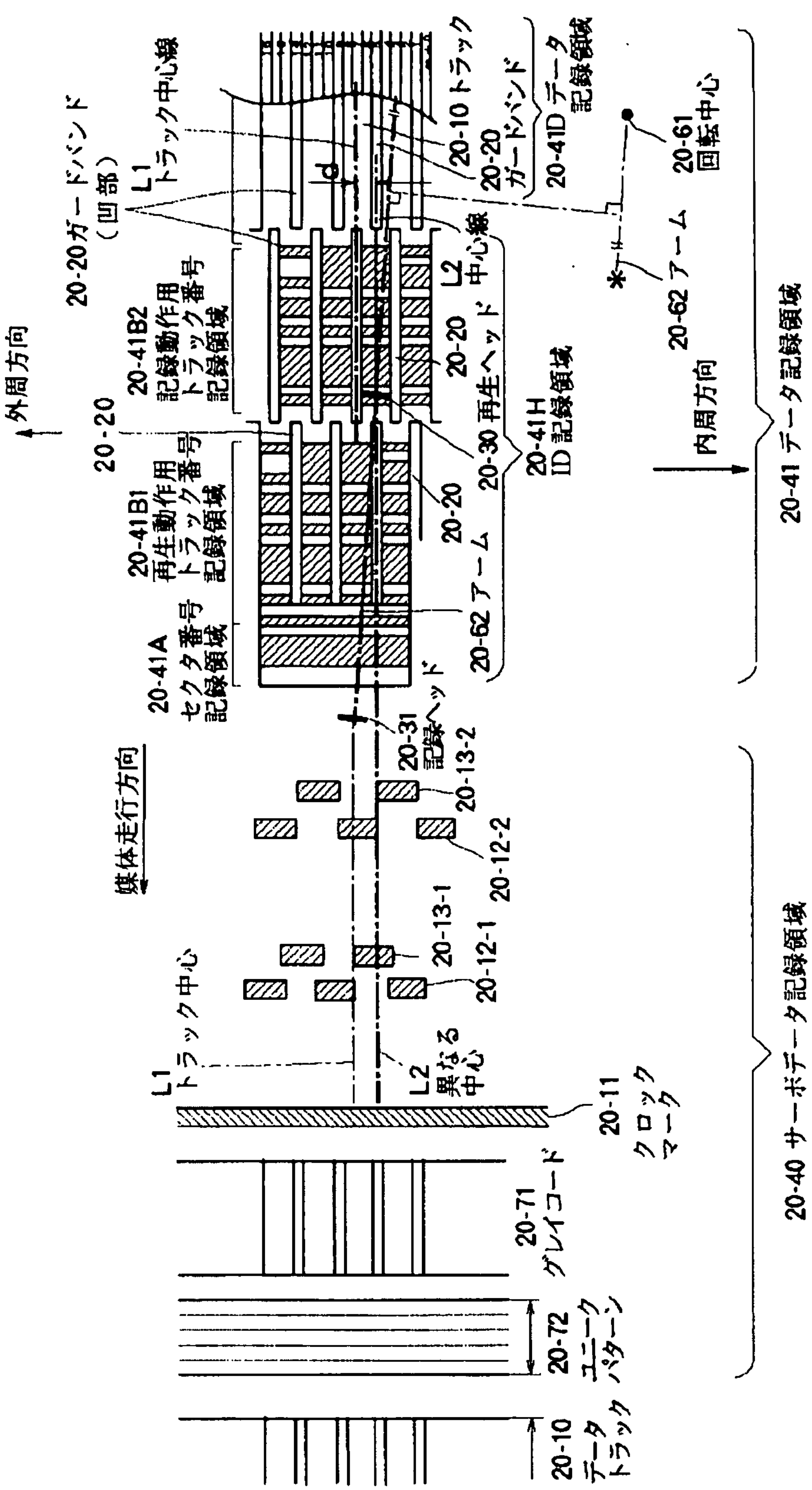
[Drawing 9]



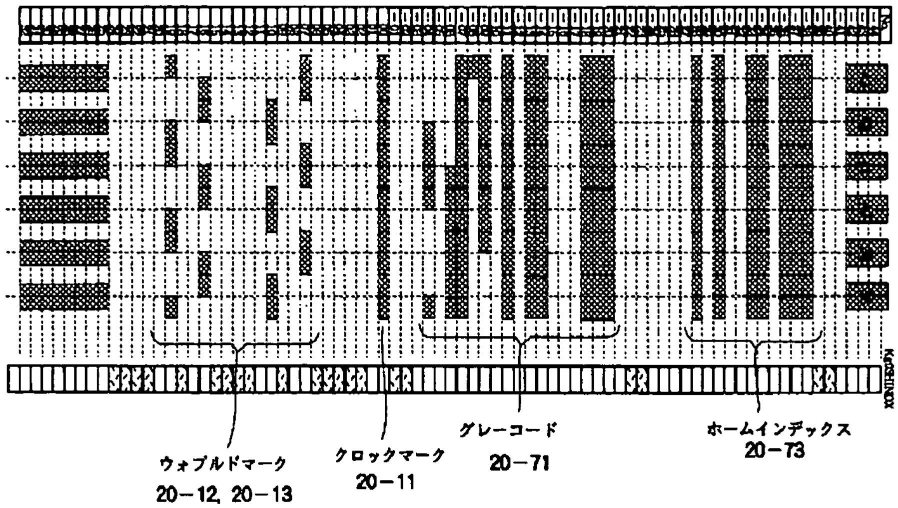
[Drawing 12]



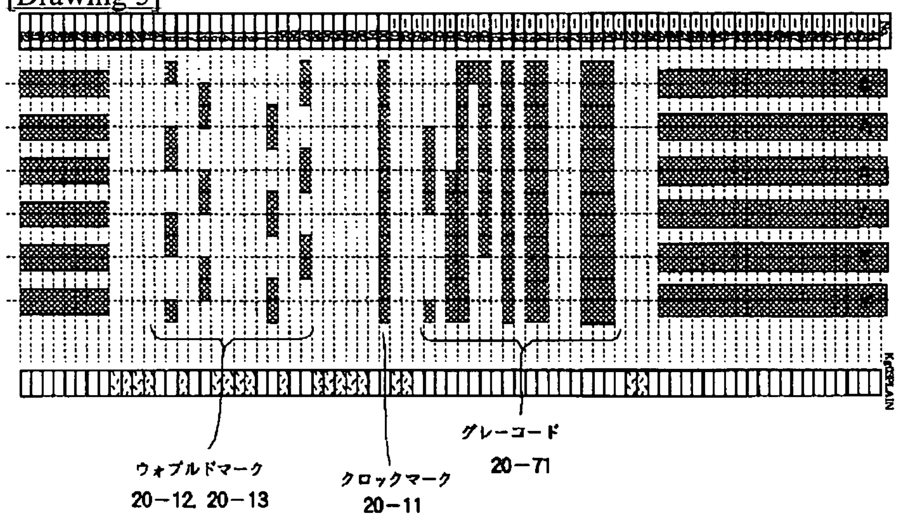
[Drawing 2]


外周方向
20-20ガードバンド（凹部）
L1 トラック中心線
d
20-10 トラック
20-20 ガードバンド
20-41D データ記録領域
20-61 回転中心
20-62 アーム
L2 中心線
20-41B2 記録動作用トラック番号記録領域
20-20
20-30 再生ヘッド
20-41H ID記録領域
20-41B1 再生動作用トラック番号記録領域
20-62 アーム
20-41A セクタ番号記録領域
20-31 記録ヘッド
内周方向
20-41 データ記録領域
媒体走行方向
20-13-2
20-12-2
20-13-1
20-12-1
L1 トラック中心
L2 異なる中心
20-11 クロックマーク
20-71 グレイコード
20-72 ユニークパターン
20-10 データトラック
20-40 サーボデータ記録領域

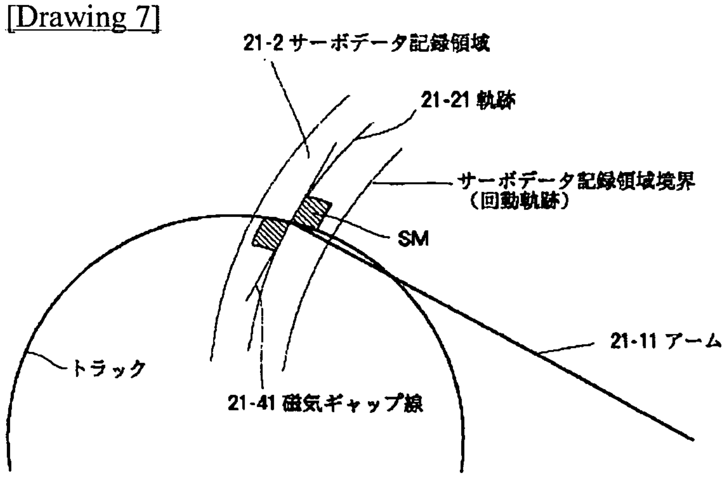
[Drawing 4]



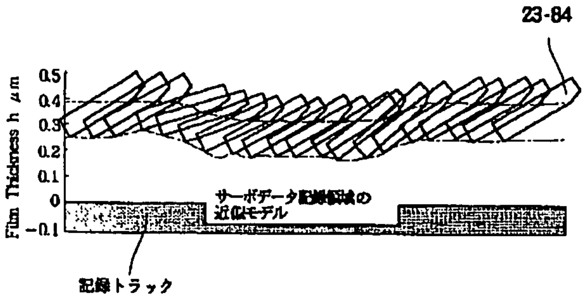
[Drawing 5]



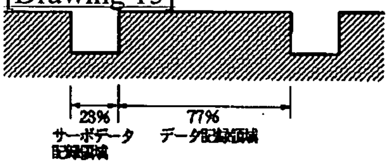
[Drawing 7]



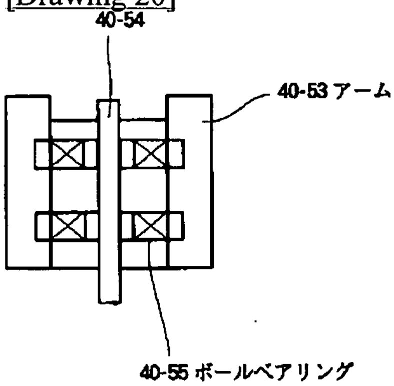
[Drawing 14]



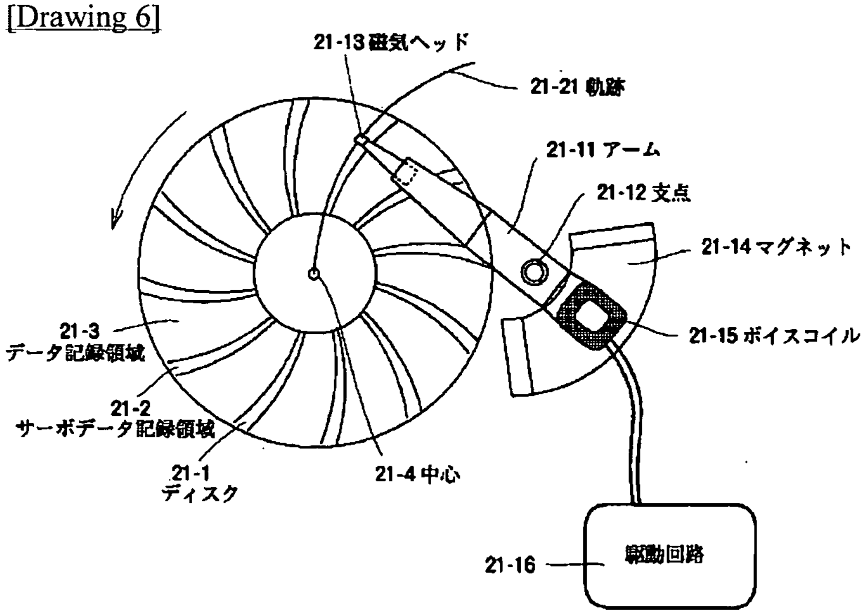
[Drawing 15]



[Drawing 20]

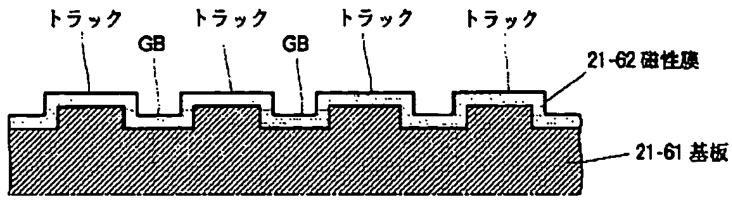


[Drawing 6]

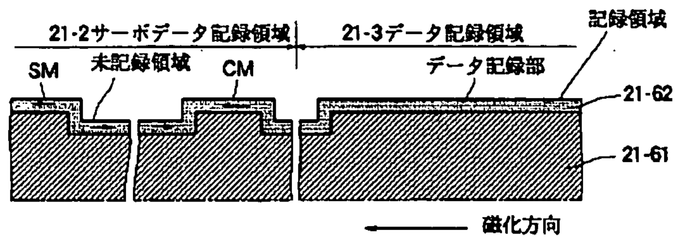


[Drawing 8]

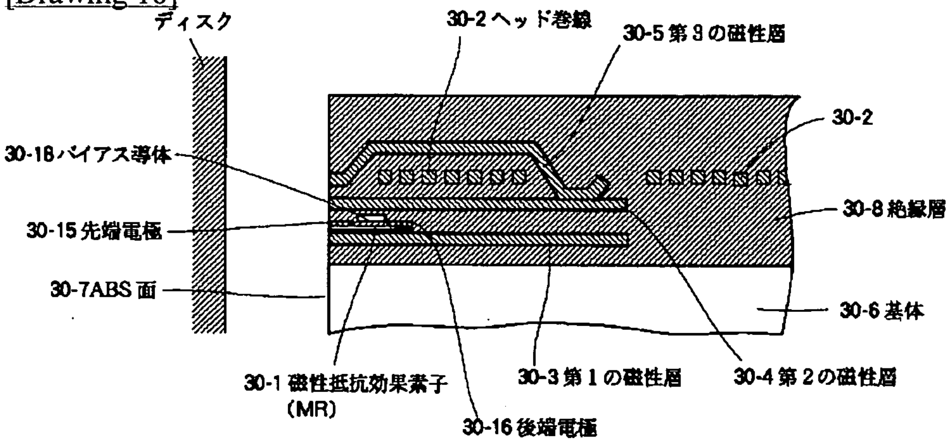
(a)



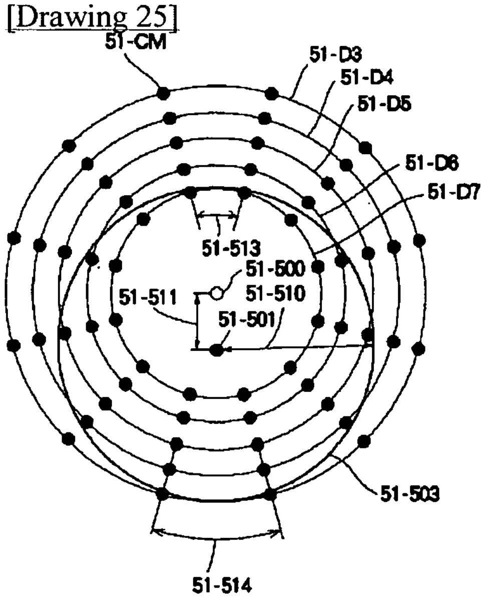
(b)



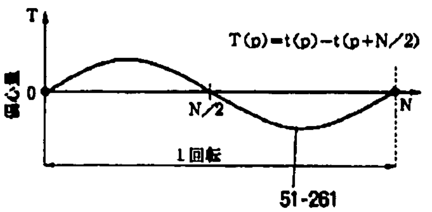
[Drawing 18]



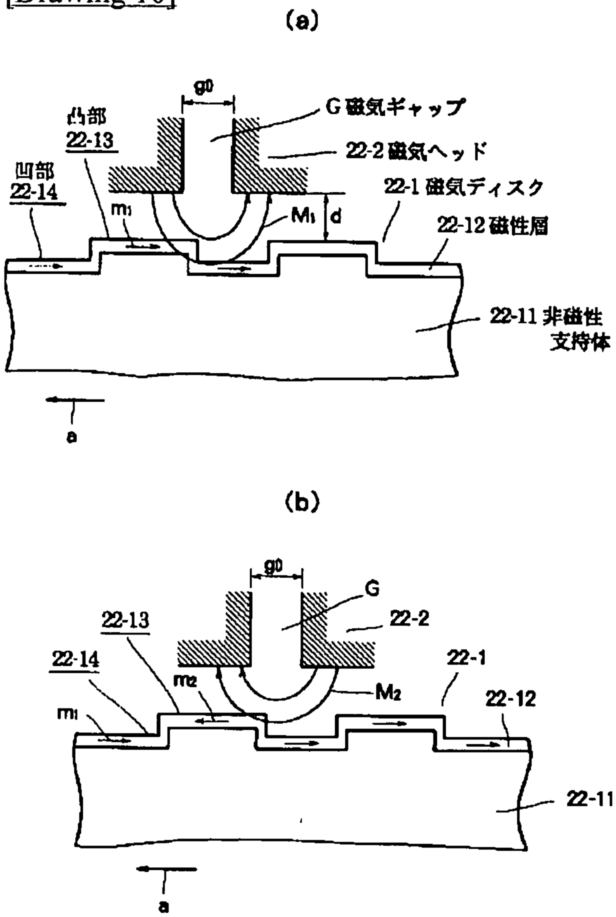
[Drawing 25]



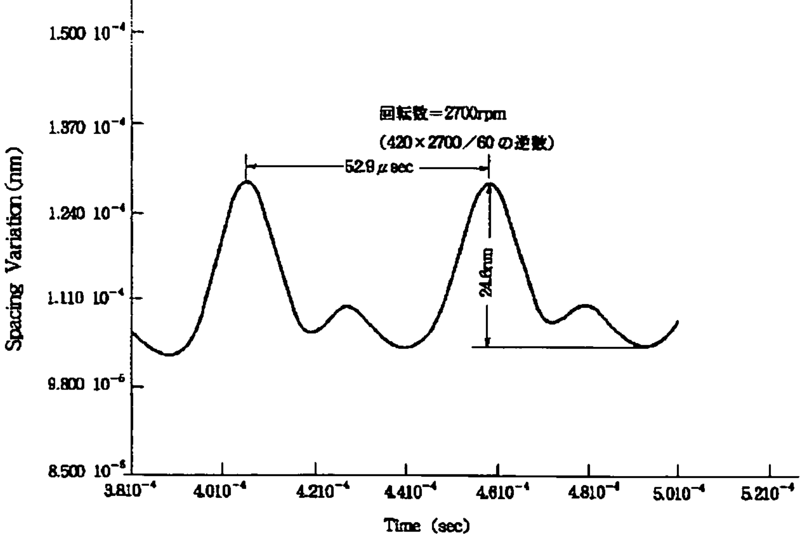
[Drawing 29]



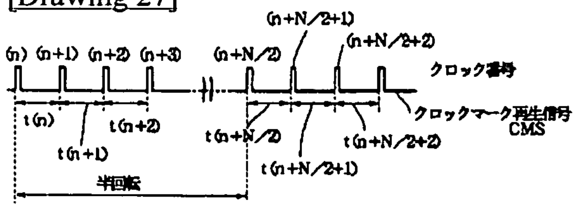
[Drawing 10]



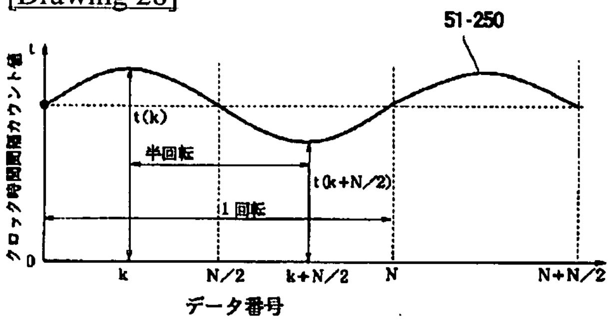
[Drawing 16]



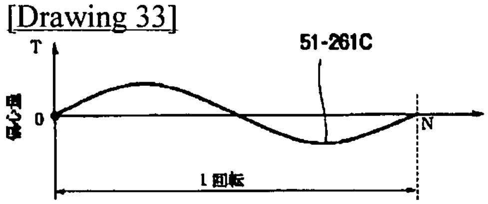
[Drawing 27]



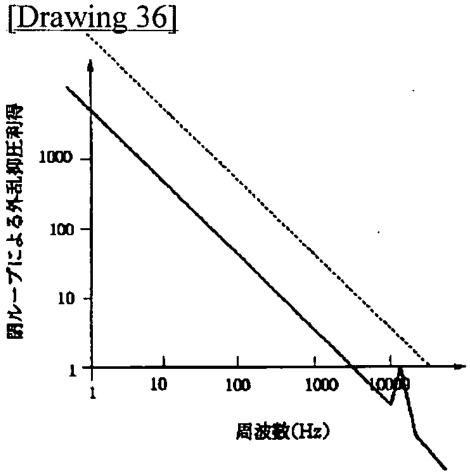
[Drawing 28]



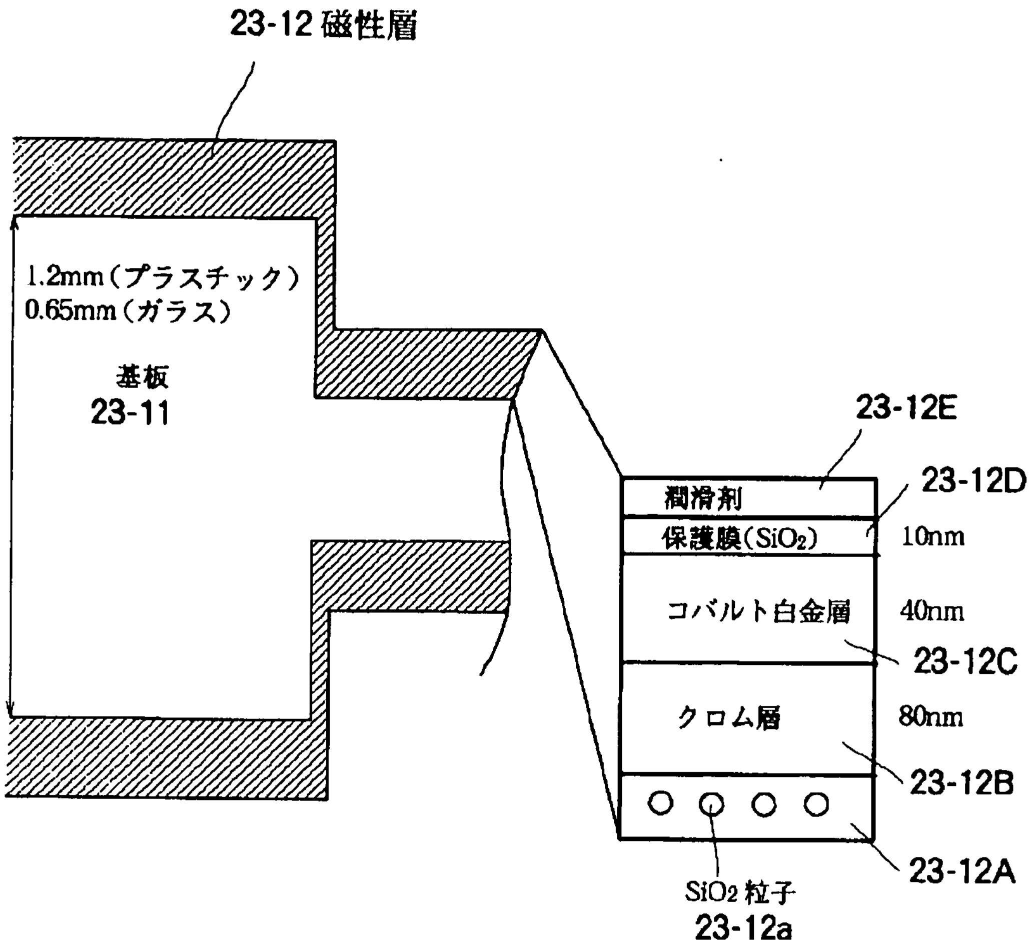
[Drawing 33]



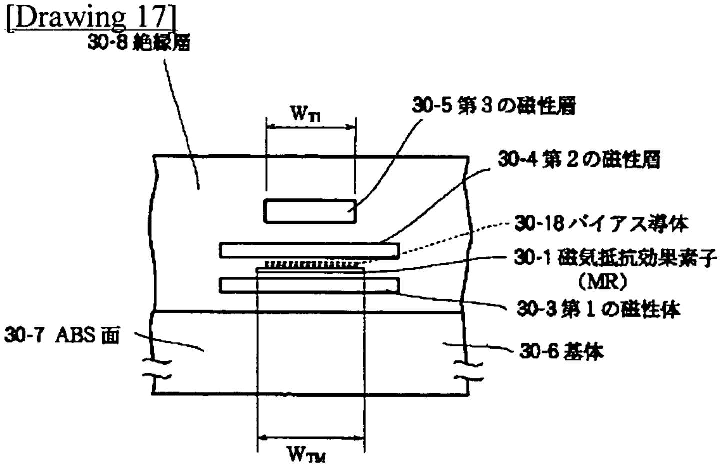
[Drawing 36]



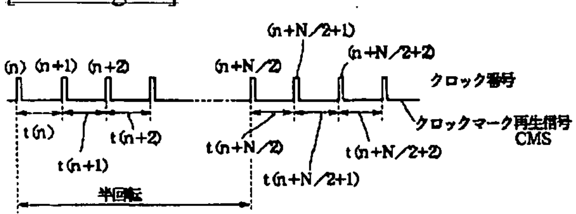
[Drawing 11]



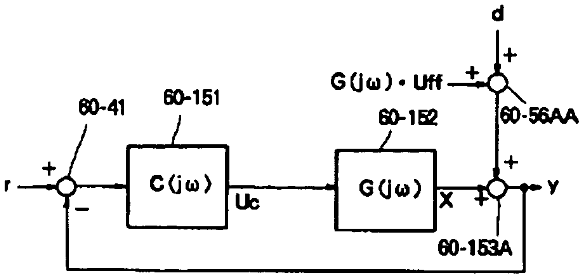
[Drawing 17]



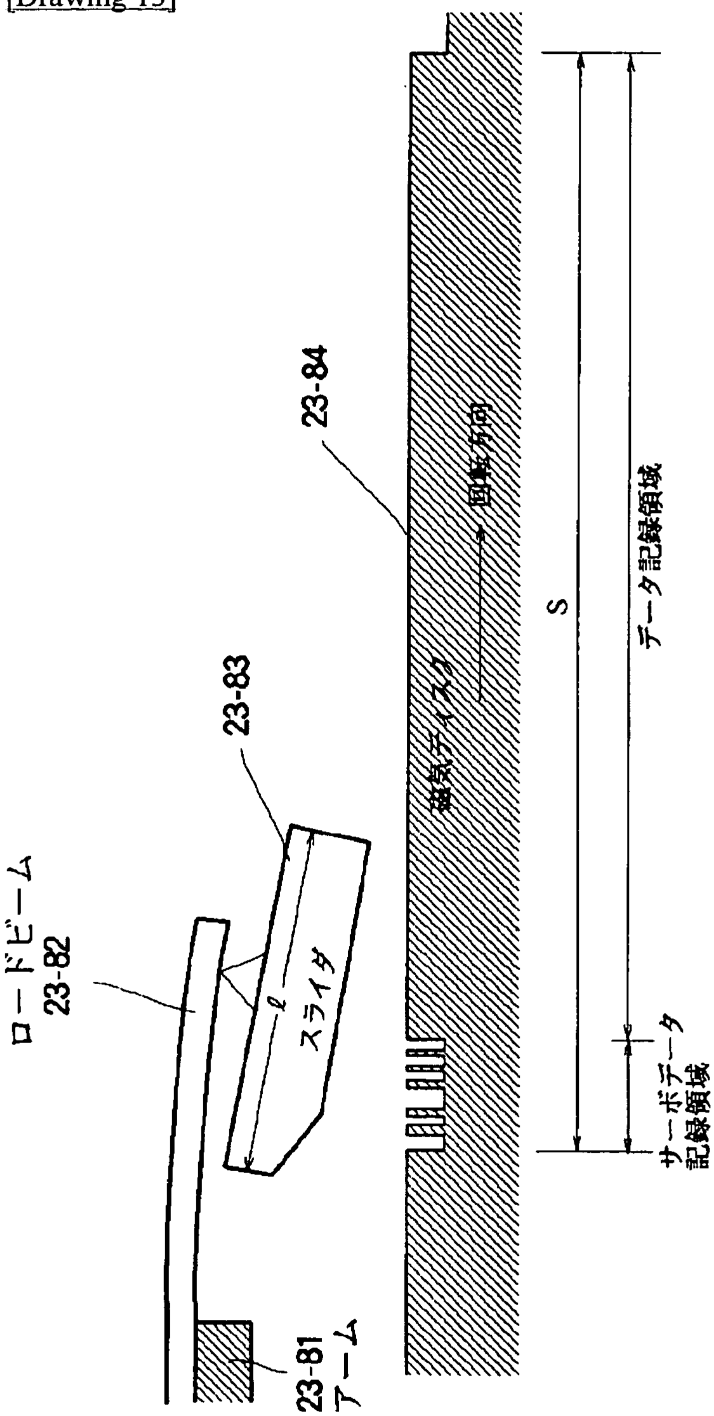
[Drawing 31]



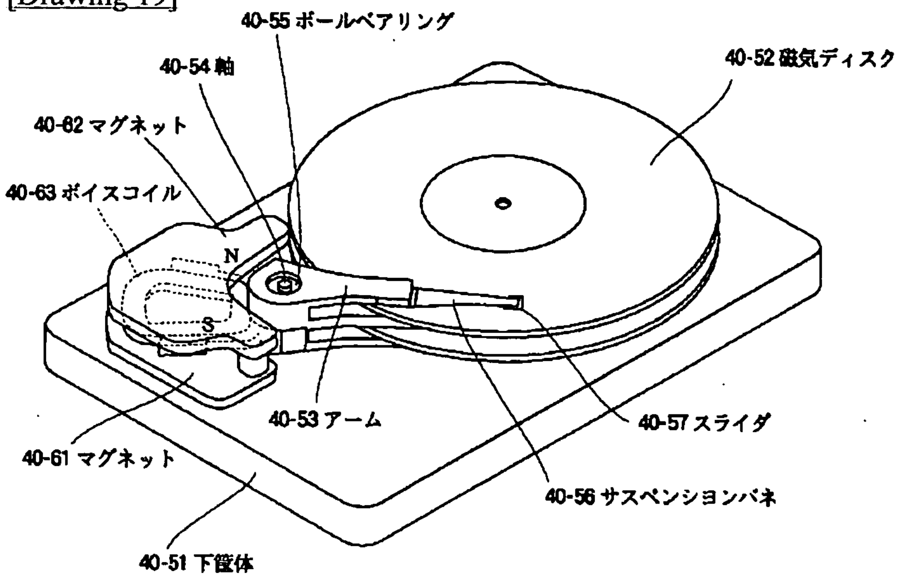
[Drawing 35]


d
G(jω)・Uff
60-56AA
60-41
60-151
60-152
r
C(jω)
Uc
G(jω)
X
Y
60-153A

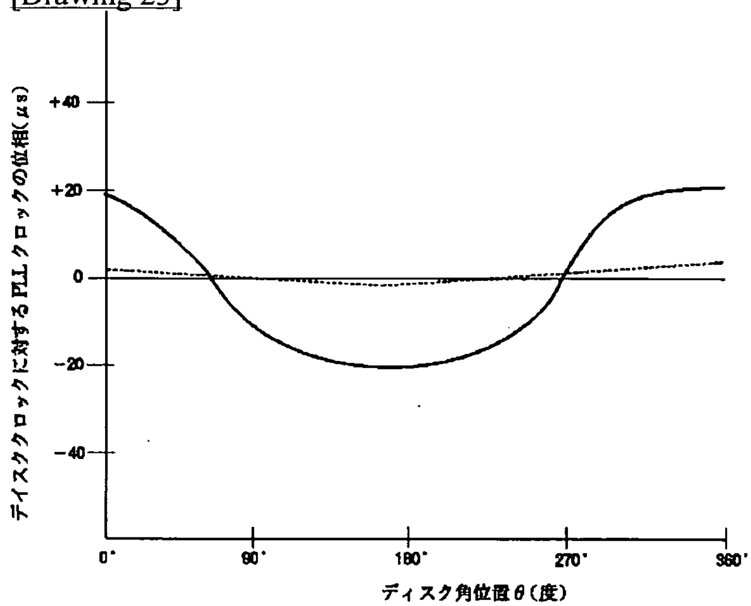
[Drawing 13]


ロードビーム
23-82
23-83
23-84
スライダ
ℓ
磁気ディスク
回転方向
S
データ記録領域
サーボデータ記録領域
23-81
アーム

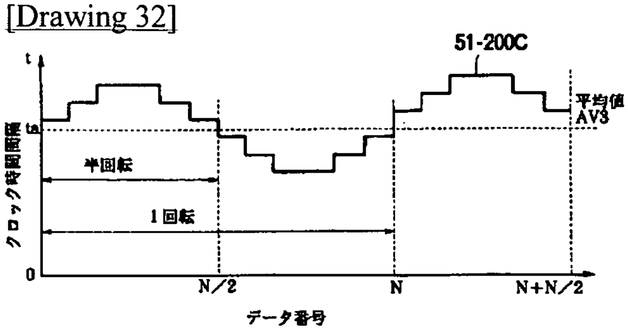
[Drawing 19]



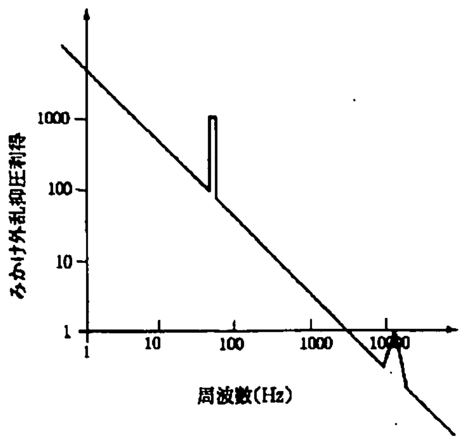
[Drawing 23]



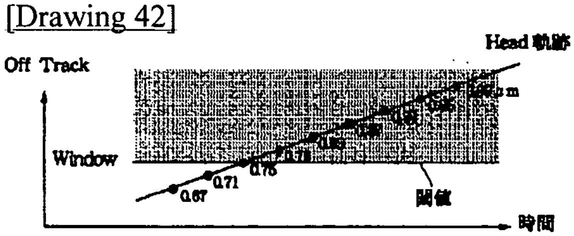
[Drawing 32]



[Drawing 37]

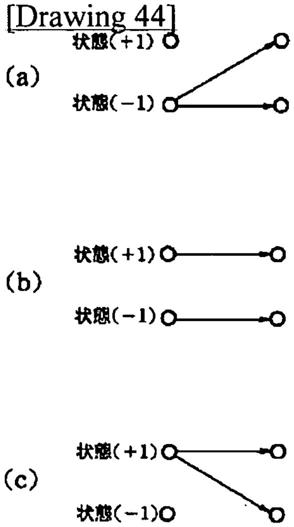


[Drawing 42]

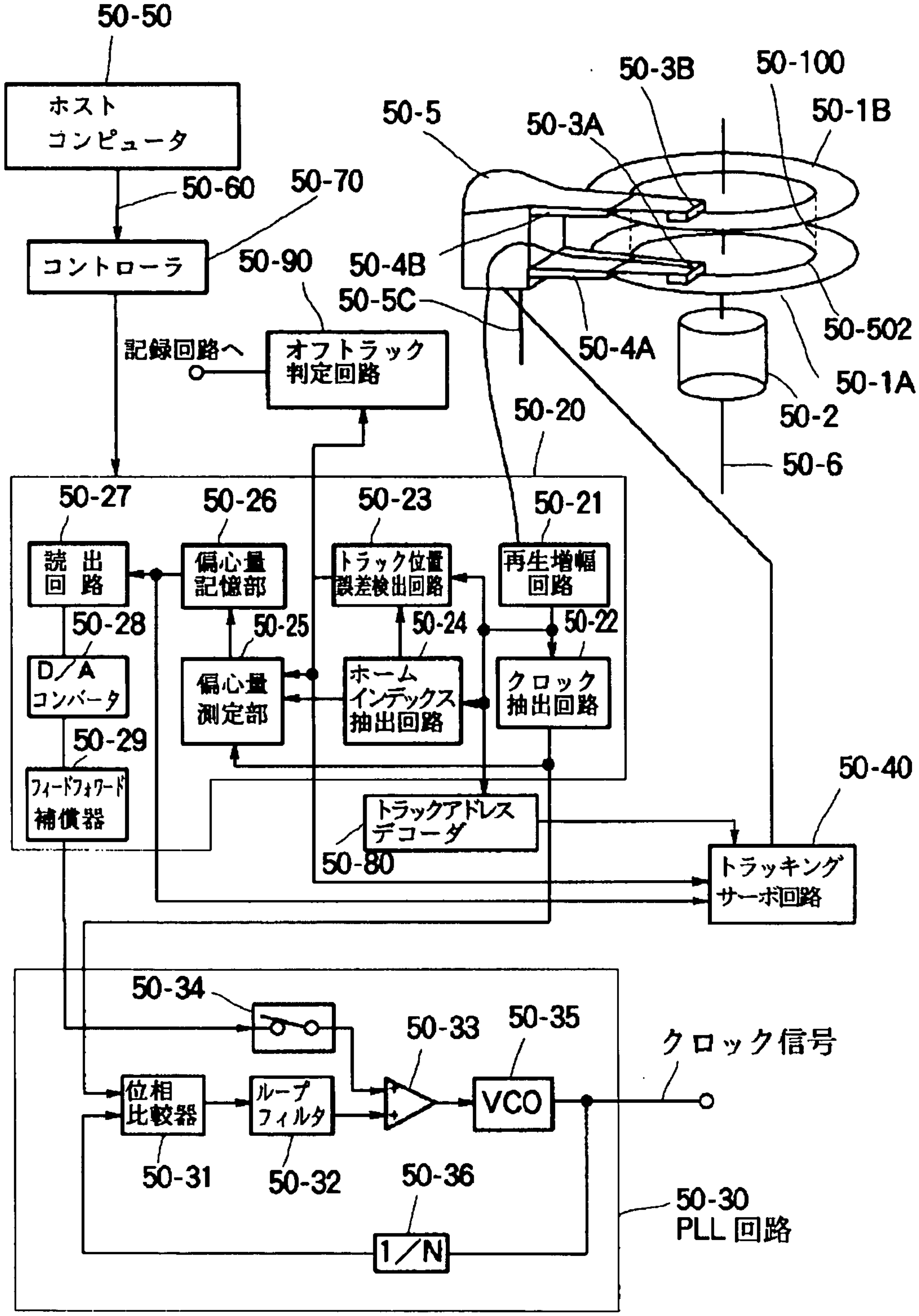


100G Shock 時の head 軌跡(最悪 Case)

[Drawing 44]

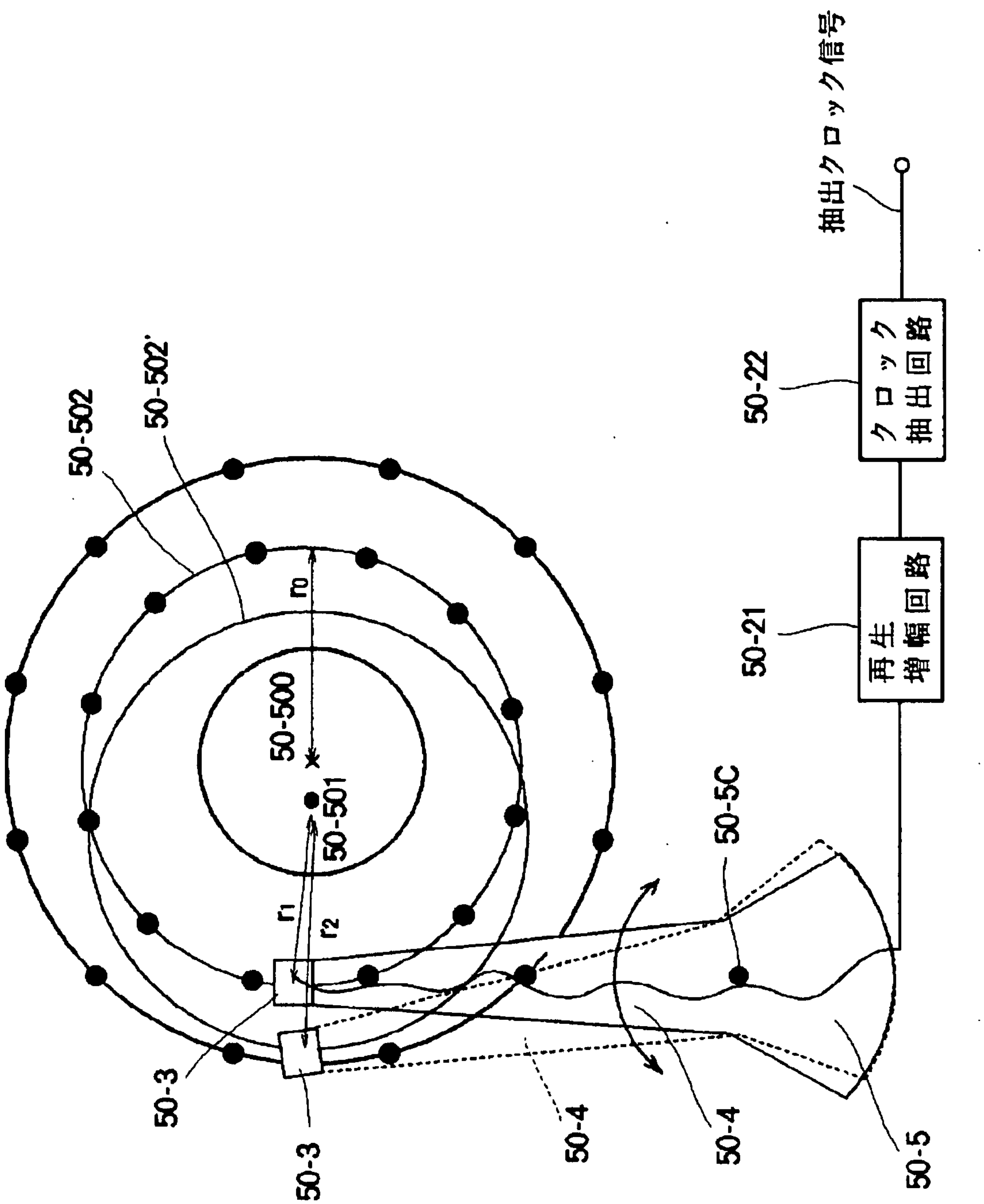


[Drawing 21]

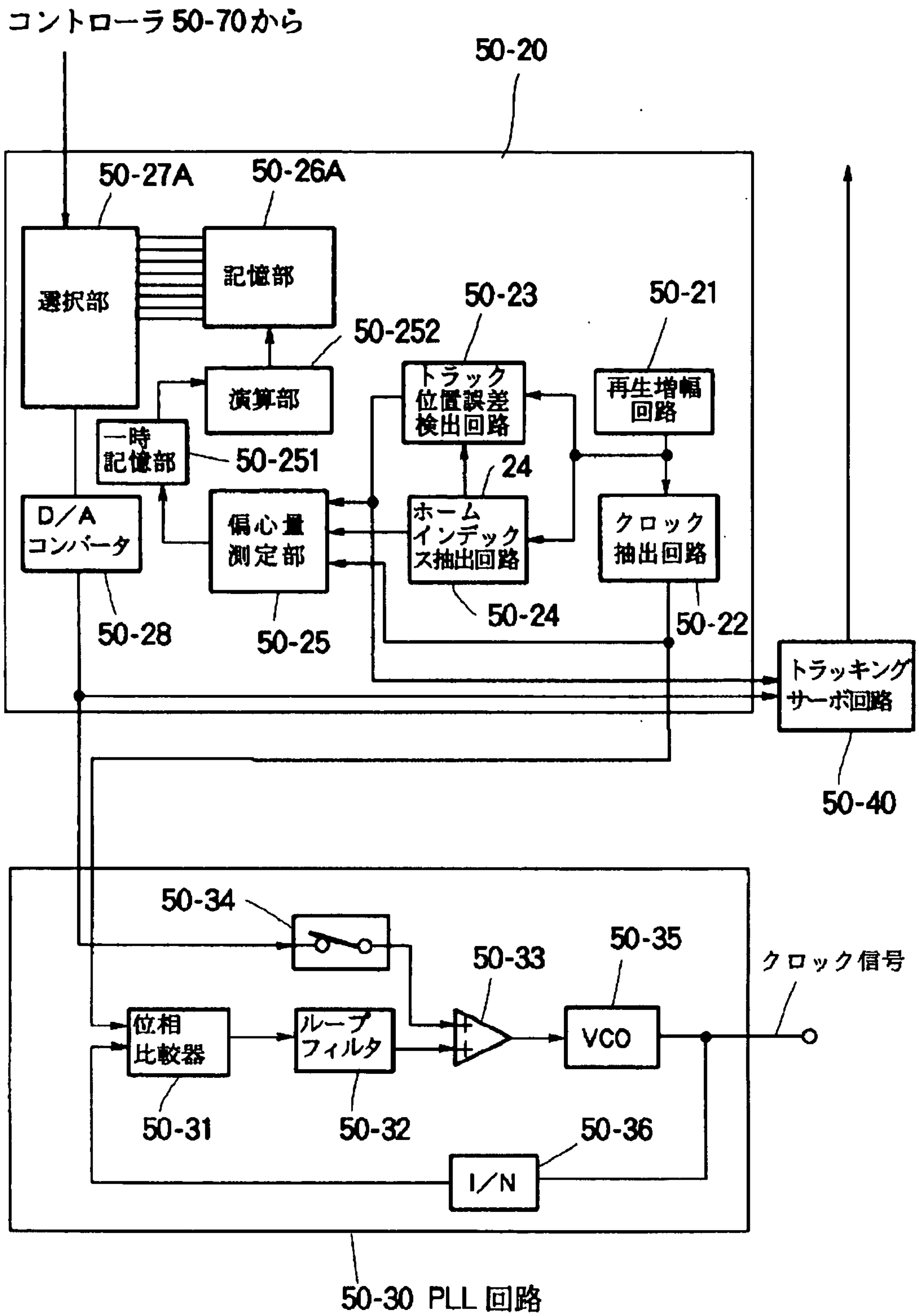


50-50
ホスト
コンピュータ
50-60
50-70
コントローラ
50-90
記録回路へ
オフトラック
判定回路
50-5
50-3B
50-100
50-1B
50-3A
50-4B
50-5C
50-4A
50-502
50-1A
50-2
50-6
50-20
50-27
50-26
50-23
50-21
読出
回路
偏心量
記憶部
トラック位置
誤差検出回路
再生増幅
回路
50-28
50-25
50-24
50-22
D/A
コンバータ
偏心量
測定部
ホーム
インデックス
抽出回路
クロック
抽出回路
50-29
フィードフォワード
補償器
トラックアドレス
デコーダ
50-80
50-40
トラッキング
サーボ回路
50-34
50-33
50-35
クロック信号
位相
比較器
ループ
フィルタ
VCO
50-31
50-32
50-36
1/N
50-30
PLL 回路

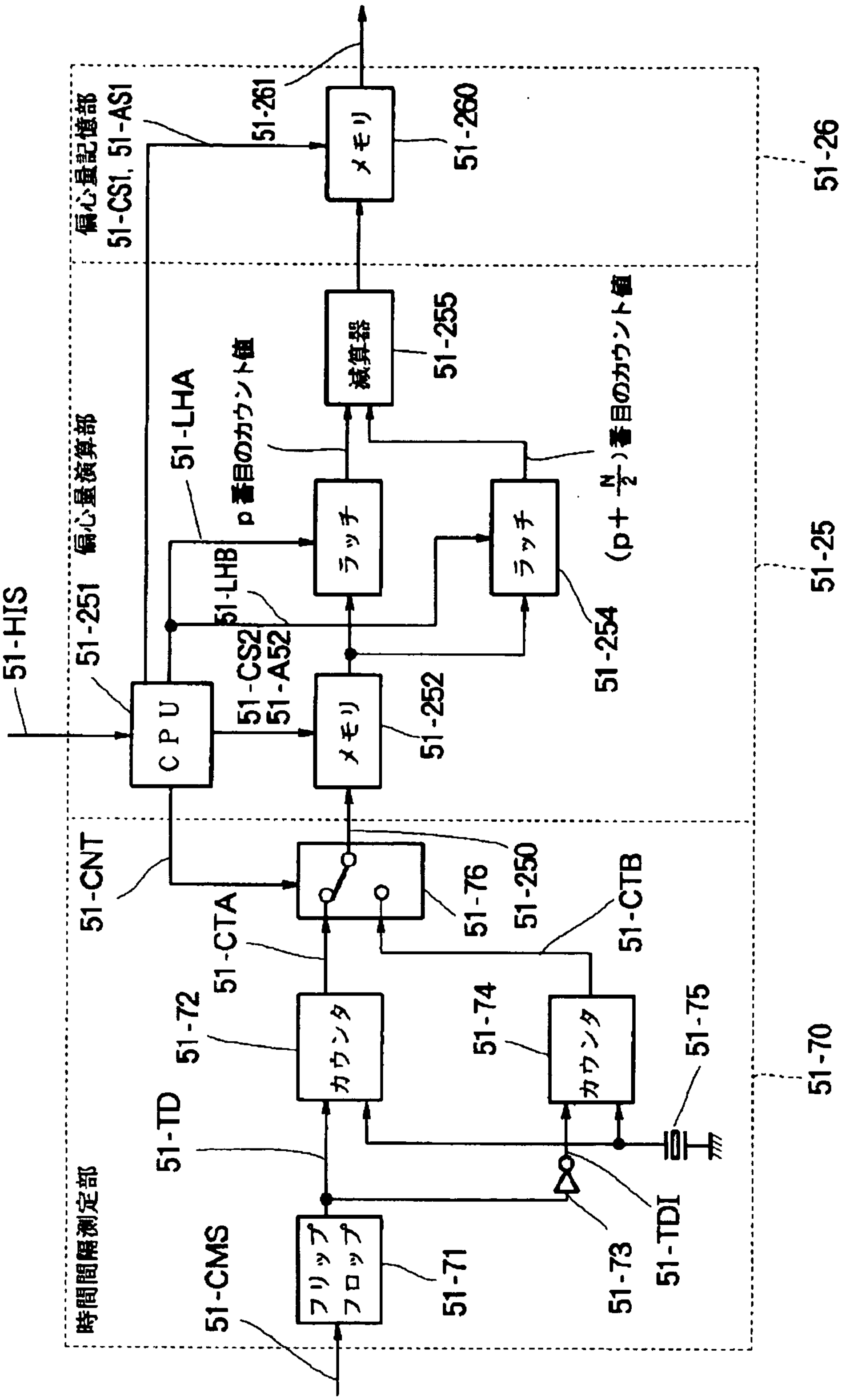
[Drawing 22]


50-502
50-502'
50-500
50-501
r0
r1
r2
50-3
50-3
50-4
50-4
50-5
50-5C
50-21
50-22
再生
増幅回路
クロック
抽出回路
抽出クロック信号

[Drawing 24]

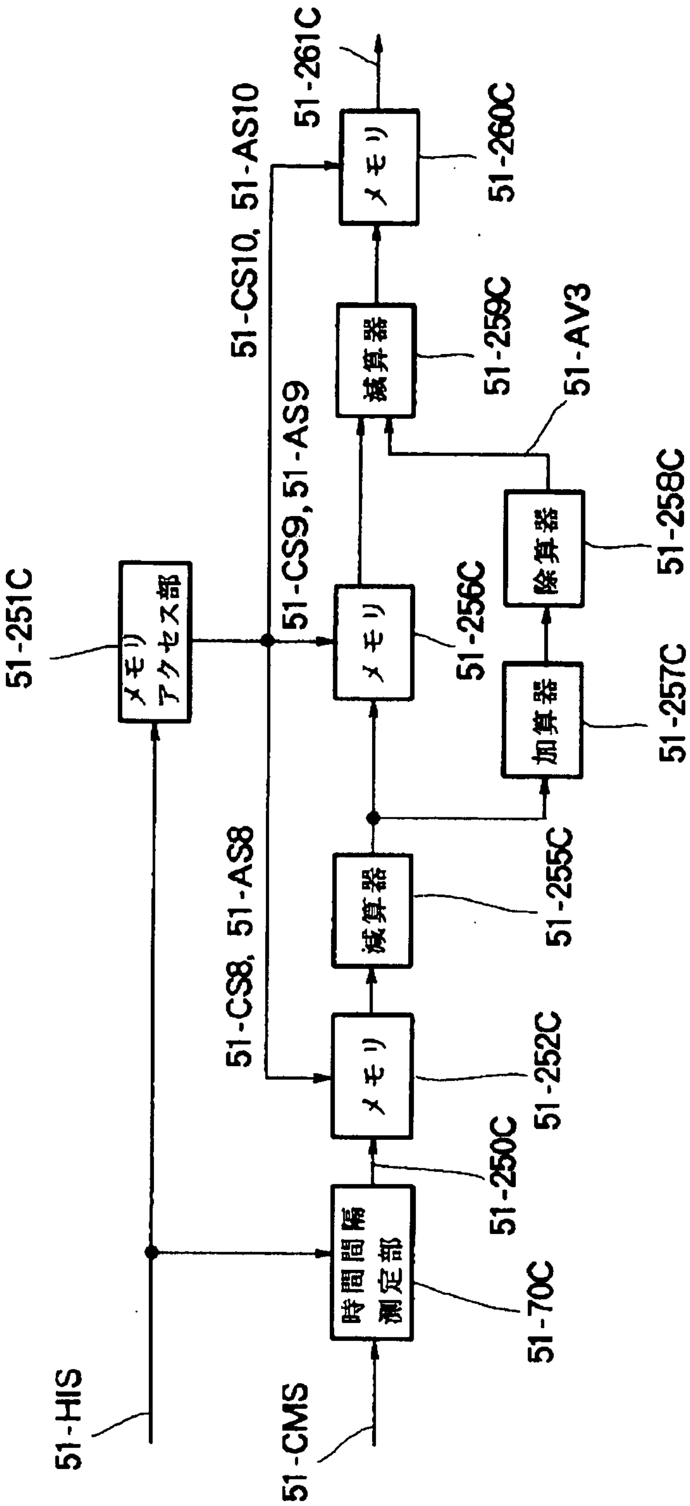

コントローラ50-70から
50-20
50-27A
50-26A
選択部
記憶部
50-23
50-21
50-252
演算部
トラック位置誤差検出回路
再生増幅回路
一時記憶部
50-251
24
D/Aコンバータ
偏心量測定部
ホームインデックス抽出回路
クロック抽出回路
50-24
50-28
50-25
50-22
トラッキングサーボ回路
50-40
50-34
50-33
50-35
クロック信号
位相比較器
ループフィルタ
VCO
50-31
50-32
50-36
I/N
50-30 PLL 回路

[Drawing 26]

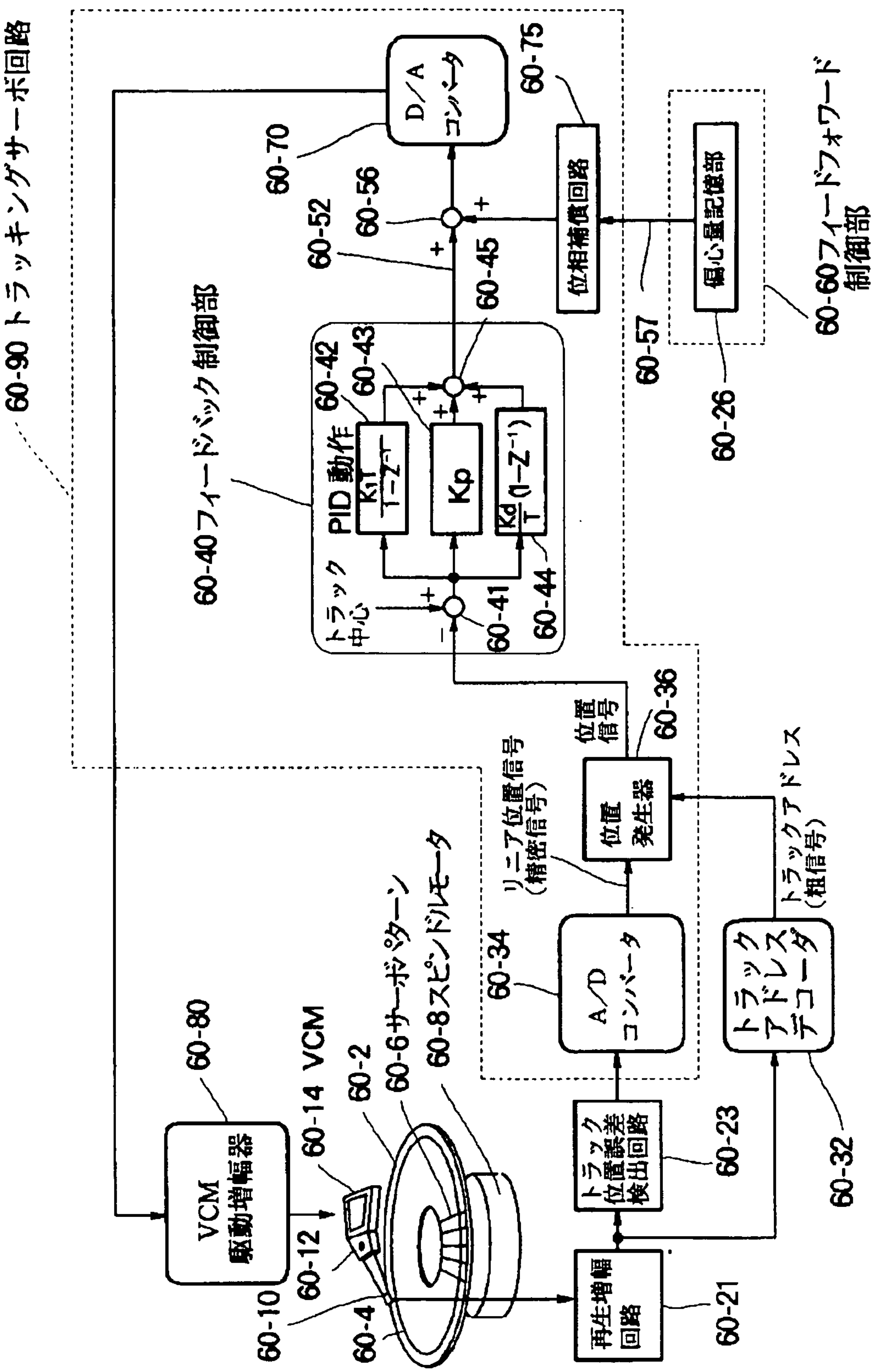


偏心量記憶部
51-CS1, 51-AS1
51-261
メモリ
51-260
51-26
偏心量演算部
51-LHA
p番目のカウント値
減算器
51-255
(p+N/2)番目のカウント値
ラッチ
ラッチ
51-LHB
51-254
51-25
51-HIS
51-251
CPU
51-CS2
51-AS2
メモリ
51-252
51-CNT
51-250
51-76
51-CTA
51-CTB
時間間隔測定部
51-72
カウンタ
51-74
カウンタ
51-75
51-70
51-TD
51-TDI
51-73
51-CMS
フリップフロップ
51-71

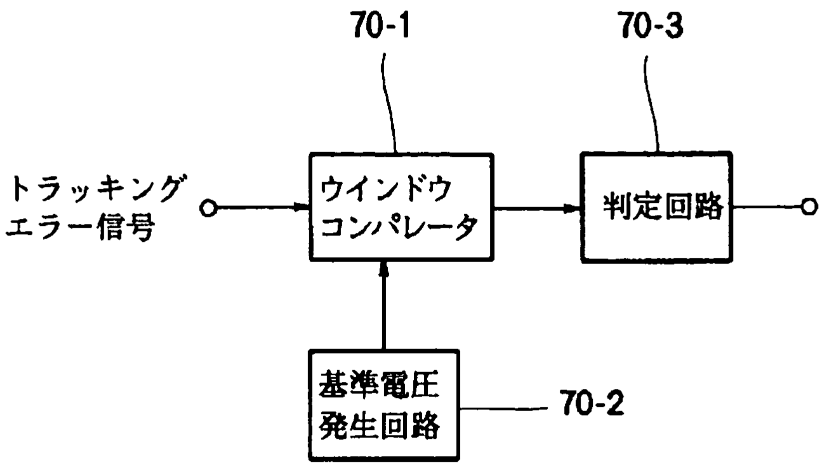
[Drawing 30]


51-HIS
51-CMS
時間間隔
測定部
51-70C
51-250C
メモリ
51-252C
51-CS8, 51-AS8
減算器
51-255C
加算器
51-257C
除算器
51-258C
メモリ
アクセス部
51-251C
メモリ
51-256C
51-CS9, 51-AS9
51-AV3
減算器
51-259C
51-CS10, 51-AS10
メモリ
51-260C
51-261C

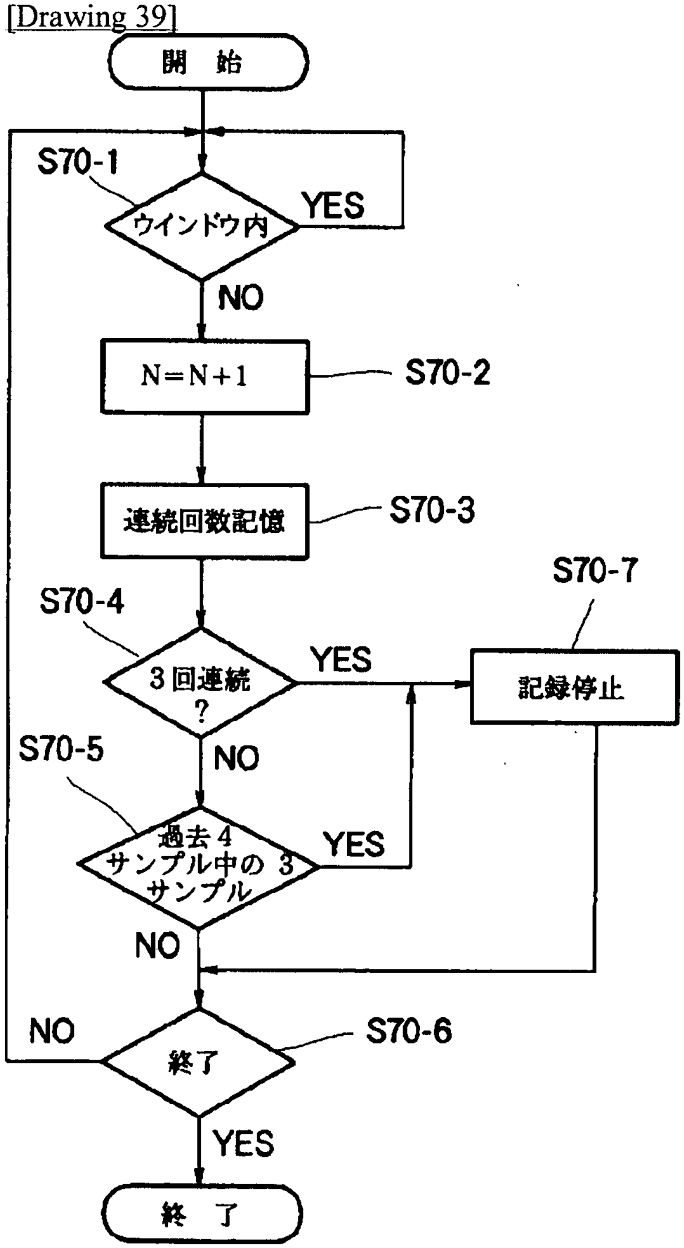
[Drawing 34]


60-90 トラッキングサーボ回路
60-40フィードバック制御部
PID動作
トラック中心
60-60フィードフォワード制御部
D/A コンバータ
位相補償回路
偏心量記憶部
位置発生器
位置信号
リニア位置信号（精密信号）
トラックアドレス（粗信号）
A/D コンバータ
トラックアドレスデコーダ
トラック位置誤差検出回路
再生増幅回路
VCM 駆動増幅器
60-14 VCM
60-6サーボパターン
60-8スピンドルモータ

[Drawing 38]

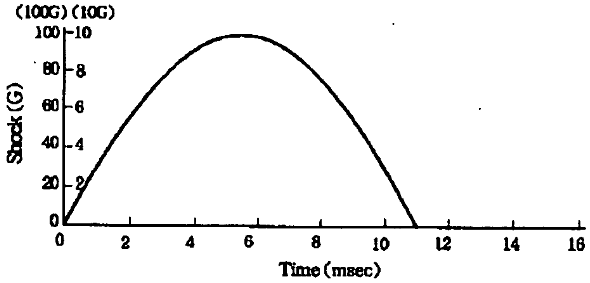


[Drawing 39]



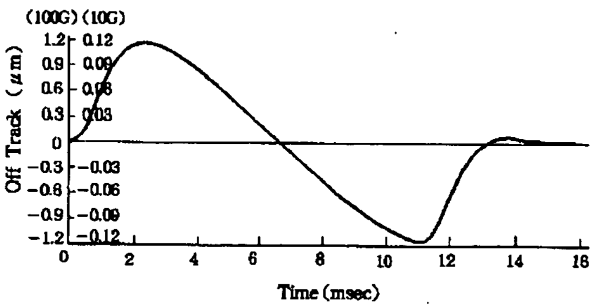
[Drawing 40]

(a)



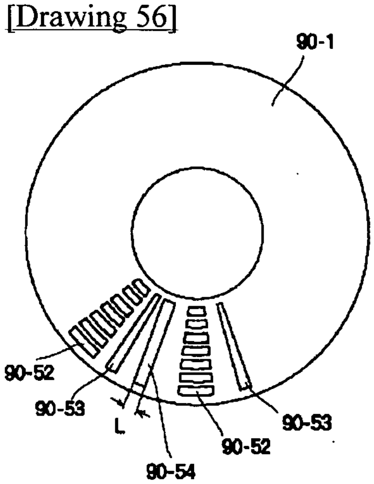
Shock Response [10G または 100G Half Sine (11msec) Shock]
Shock に対する応答波形(10G または 100GHalf Sine Shock 加算時)

(b)

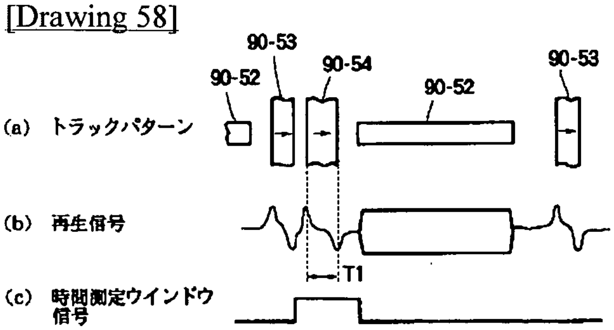


Shock Response [10G または 100G Half Sine (11msec) Shock]
Shock に対する応答波形(10G または 100GHalf Sine Shock 加算時)

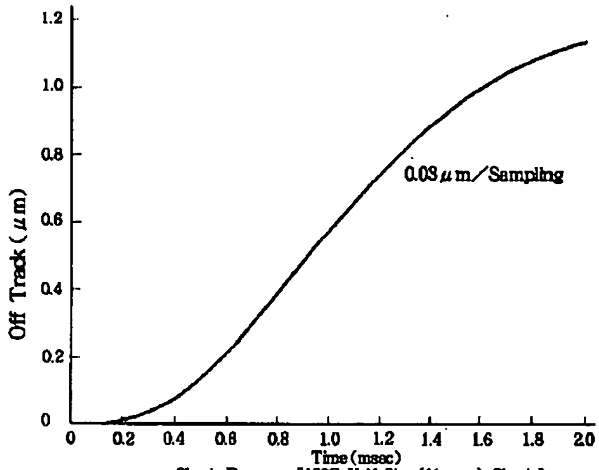
[Drawing 56]



[Drawing 58]

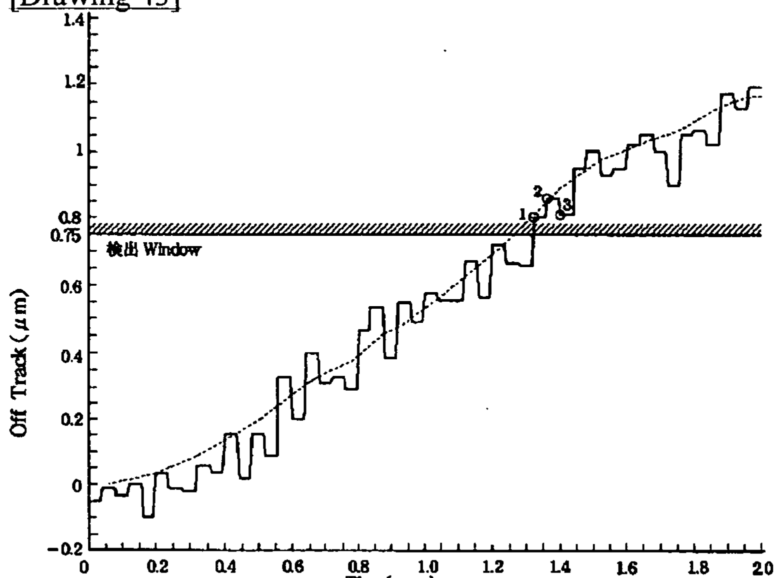


[Drawing 41]



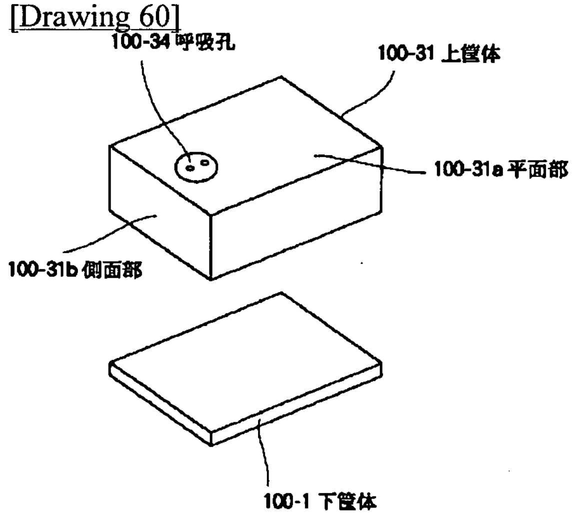
Shock Response [100G Half Sine (11msec) Shock]
Shock 応答(100G Shock 印加直後の拡大図)

[Drawing 43]

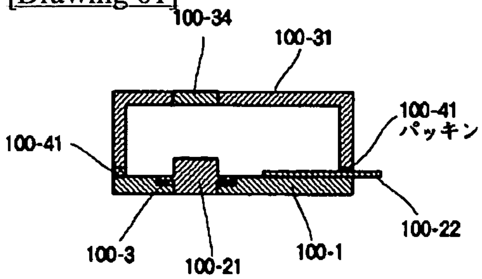


Shock Response [100G Half Sine (11msec) Shock : Noise 31dB : Sampling 25k]
Shock に対する応答波形(Shock 100G, S／N 31[dB]位置ノイズ加算時)

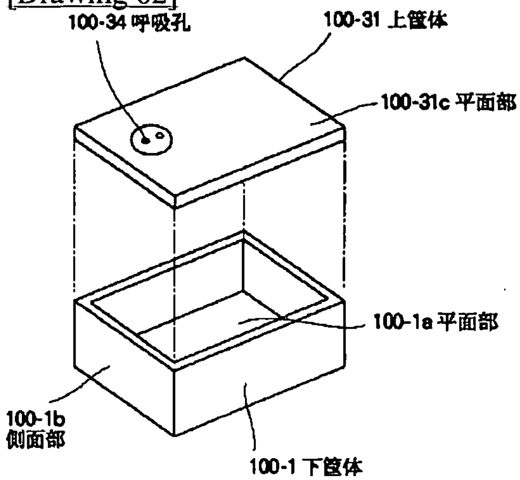
[Drawing 60]



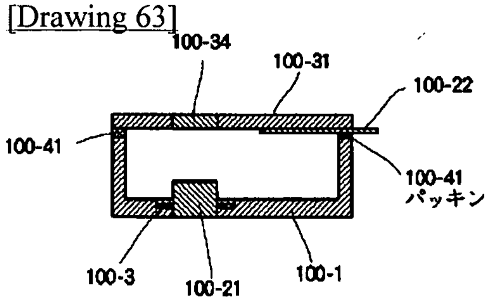
[Drawing 61]



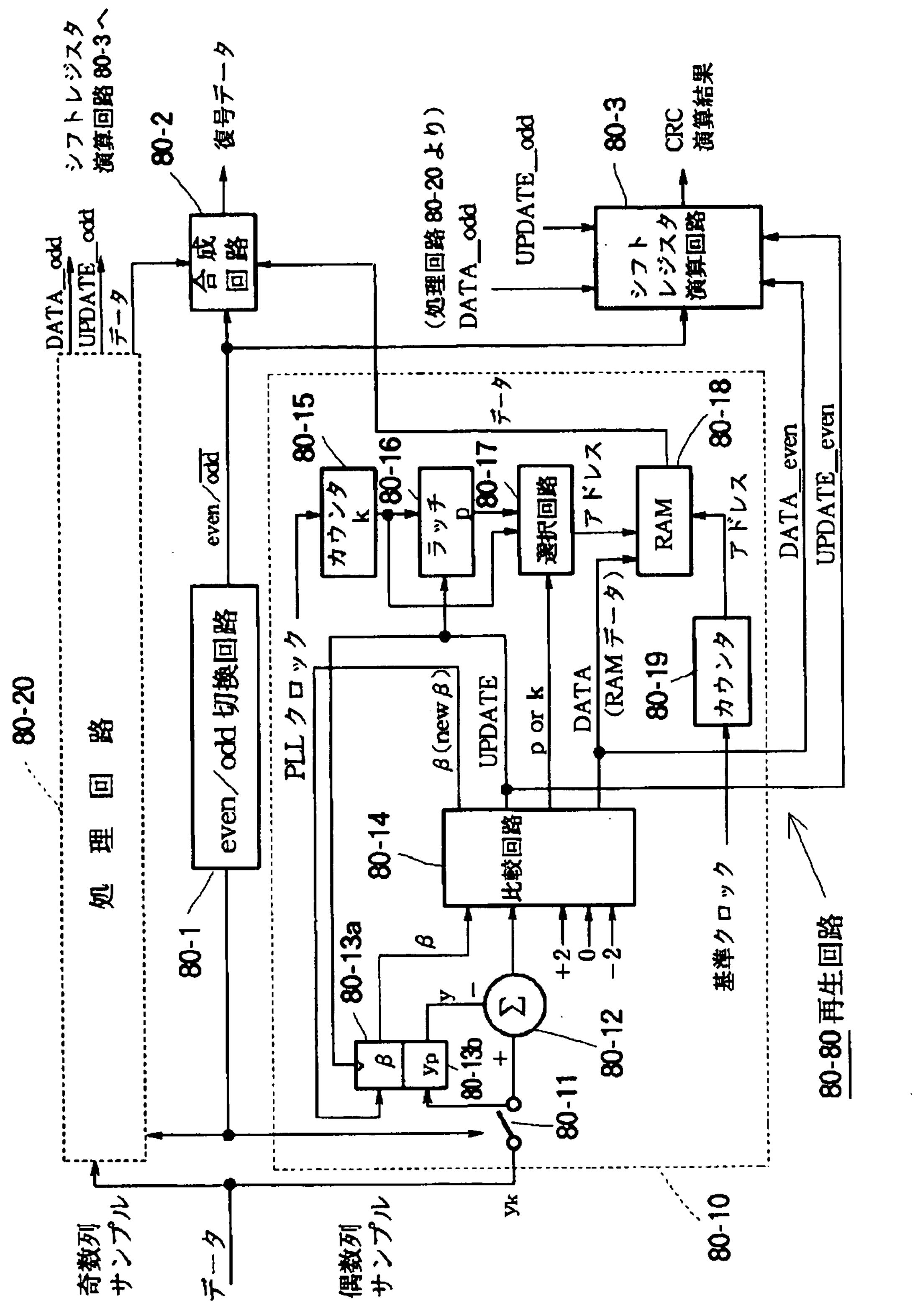
[Drawing 62]



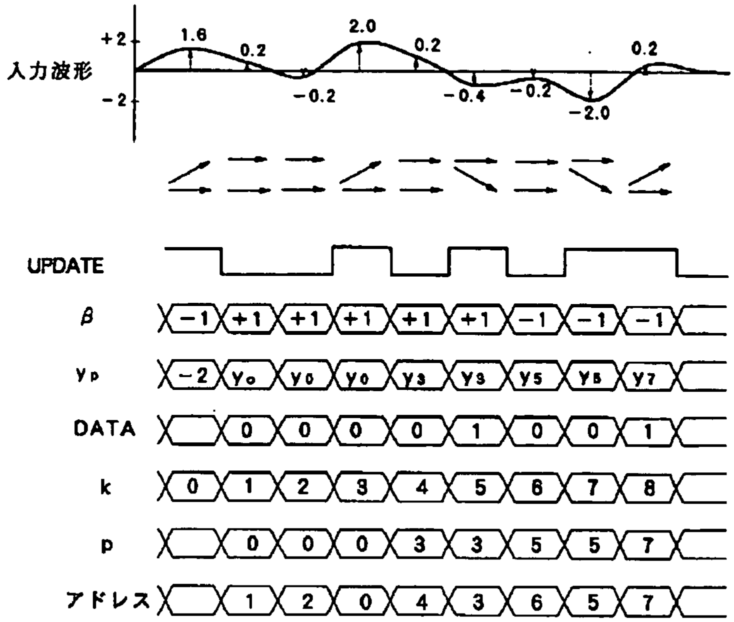
[Drawing 63]



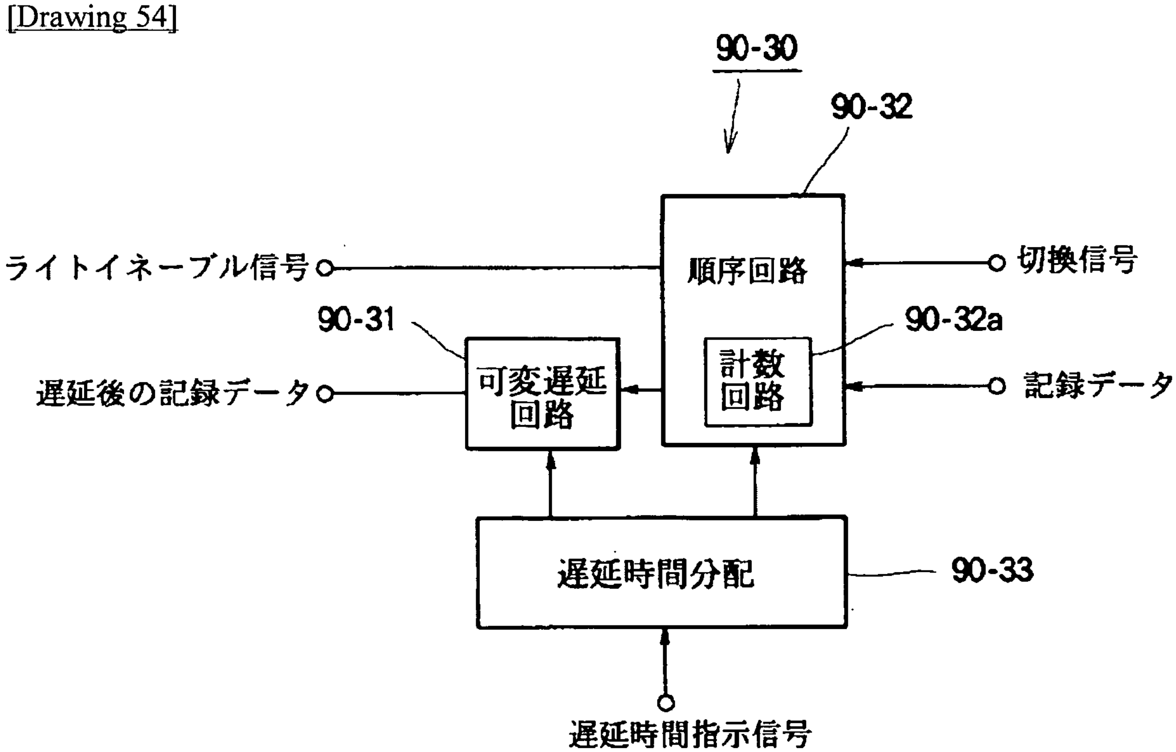
[Drawing 45]


80-20
処理回路
80-1
even／odd 切換回路
even／odd
80-2
合成回路
復号データ
シフトレジスタ演算回路 80-3へ
DATA_odd
UPDATE_odd
データ
(処理回路 80-20 より)
DATA_odd
UPDATE_odd
80-3
シフトレジスタ演算回路
CRC 演算結果
80-15
カウンタ k
80-16
ラッチ p
80-17
選択回路
アドレス
RAM
80-18
DATA_even
UPDATE_even
PLL クロック
β(new β)
UPDATE
p or k
DATA
(RAM データ)
80-19
カウンタ
80-14
比較回路
+2
0
−2
基準クロック
80-13a
β
yp
80-13b
80-12
Σ
80-11
yk
80-10
80-80 再生回路
奇数列サンプル
データ
偶数列サンプル

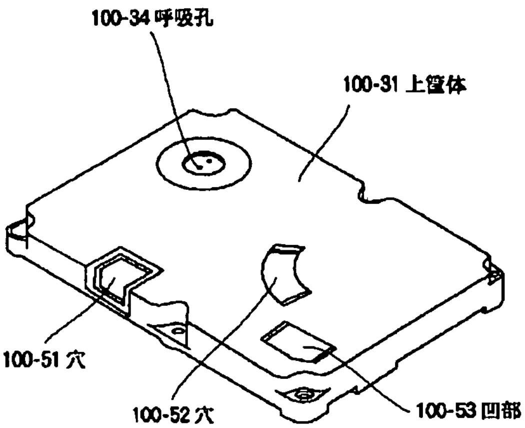
[Drawing 46]



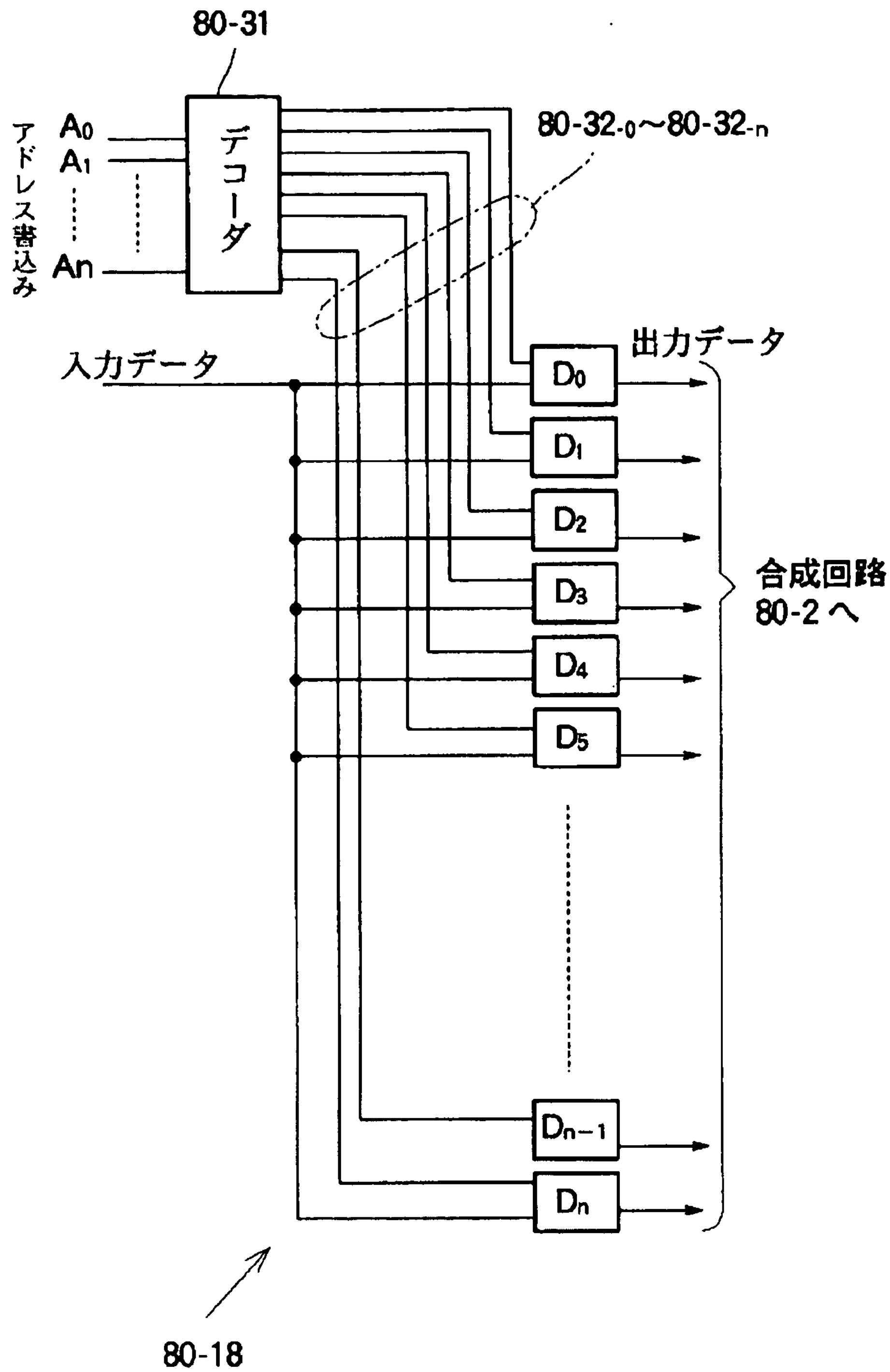
[Drawing 54]



[Drawing 64]

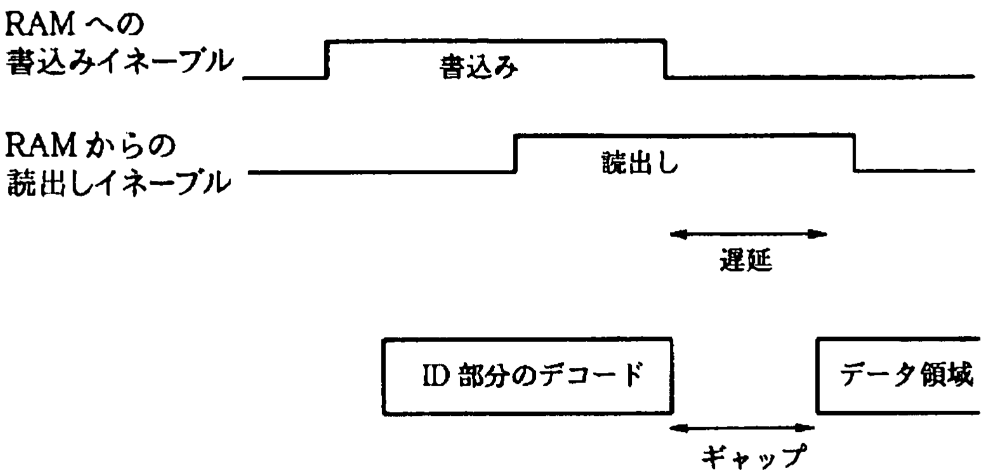


[Drawing 47]

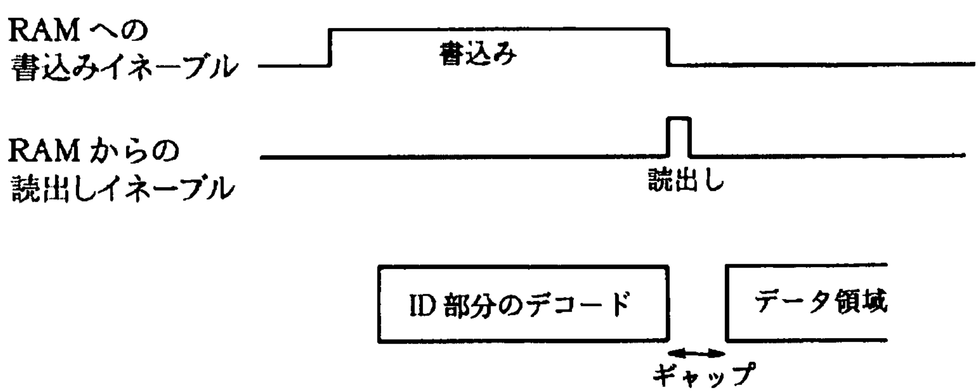

80-31
80-32-0~80-32-n
アドレス書込み
A0
A1
An
デコーダ
入力データ
出力データ
D0
D1
D2
D3
D4
D5
Dn−1
Dn
合成回路
80-2へ
80-18

[Drawing 48]

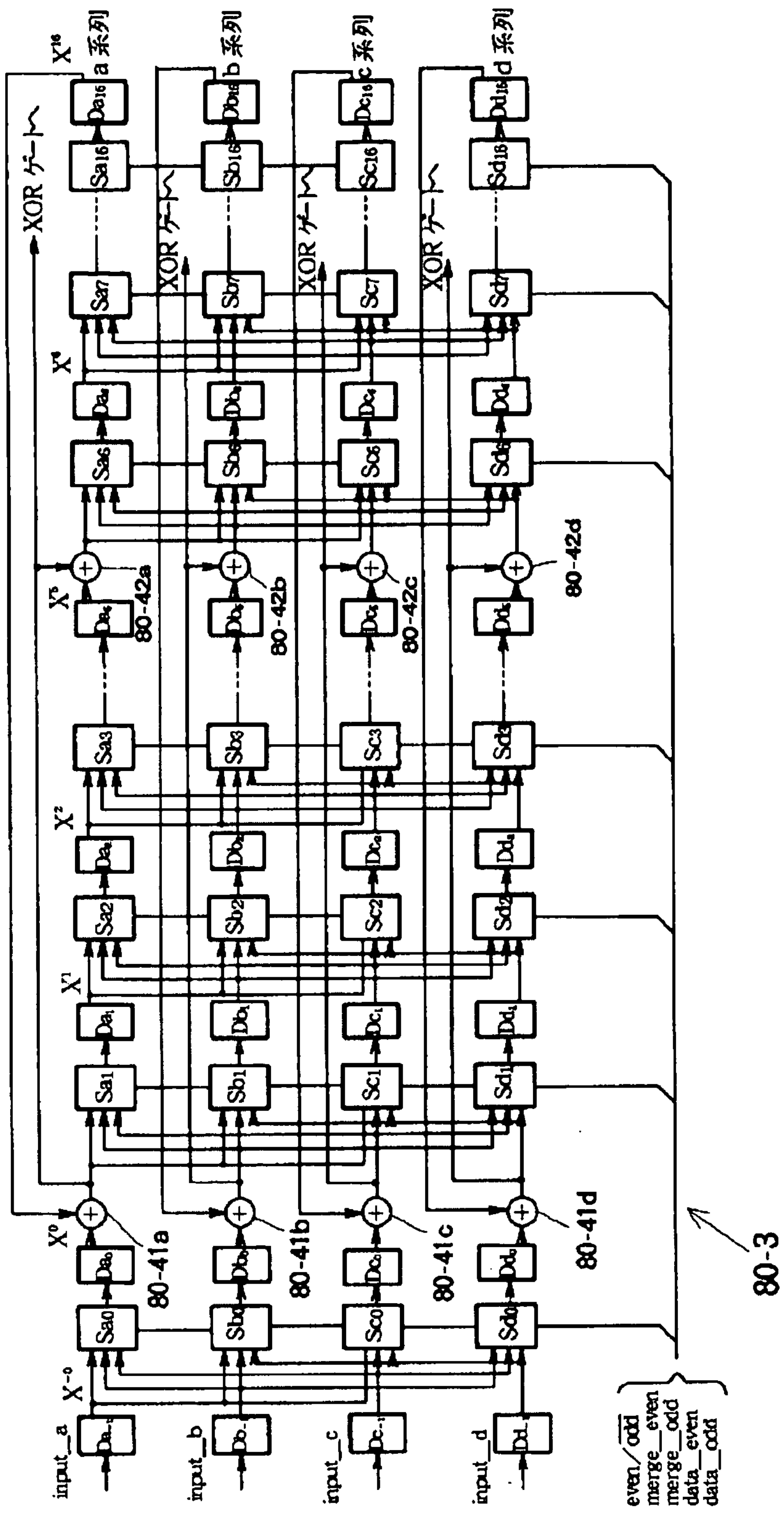
(a)従来の方式



(b)再生回路80-80の方式

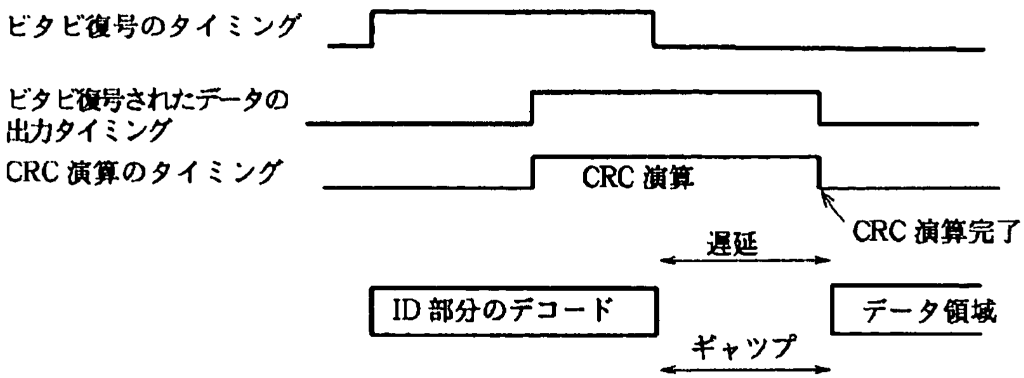


[Drawing 49]

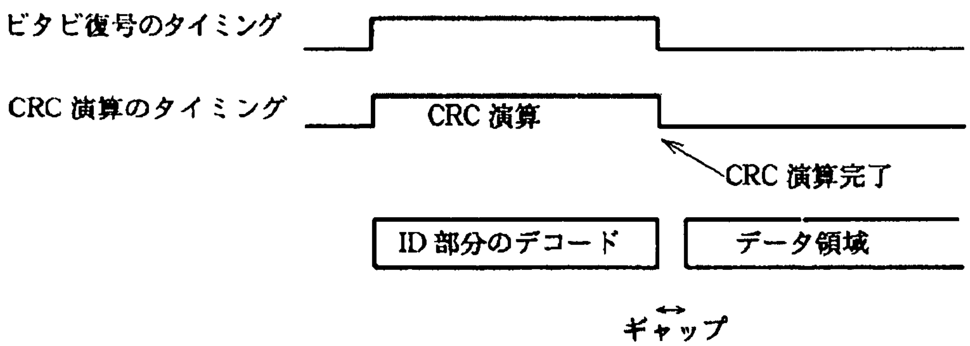

input_a
input_b
input_c
input_d
even/odd
merge_even
merge_odd
data_even
data_odd
80-41a
80-41b
80-41c
80-41d
80-42a
80-42b
80-42c
80-42d
XOR ゲートへ
a 系列
b 系列
c 系列
d 系列
80-3

[Drawing 50]

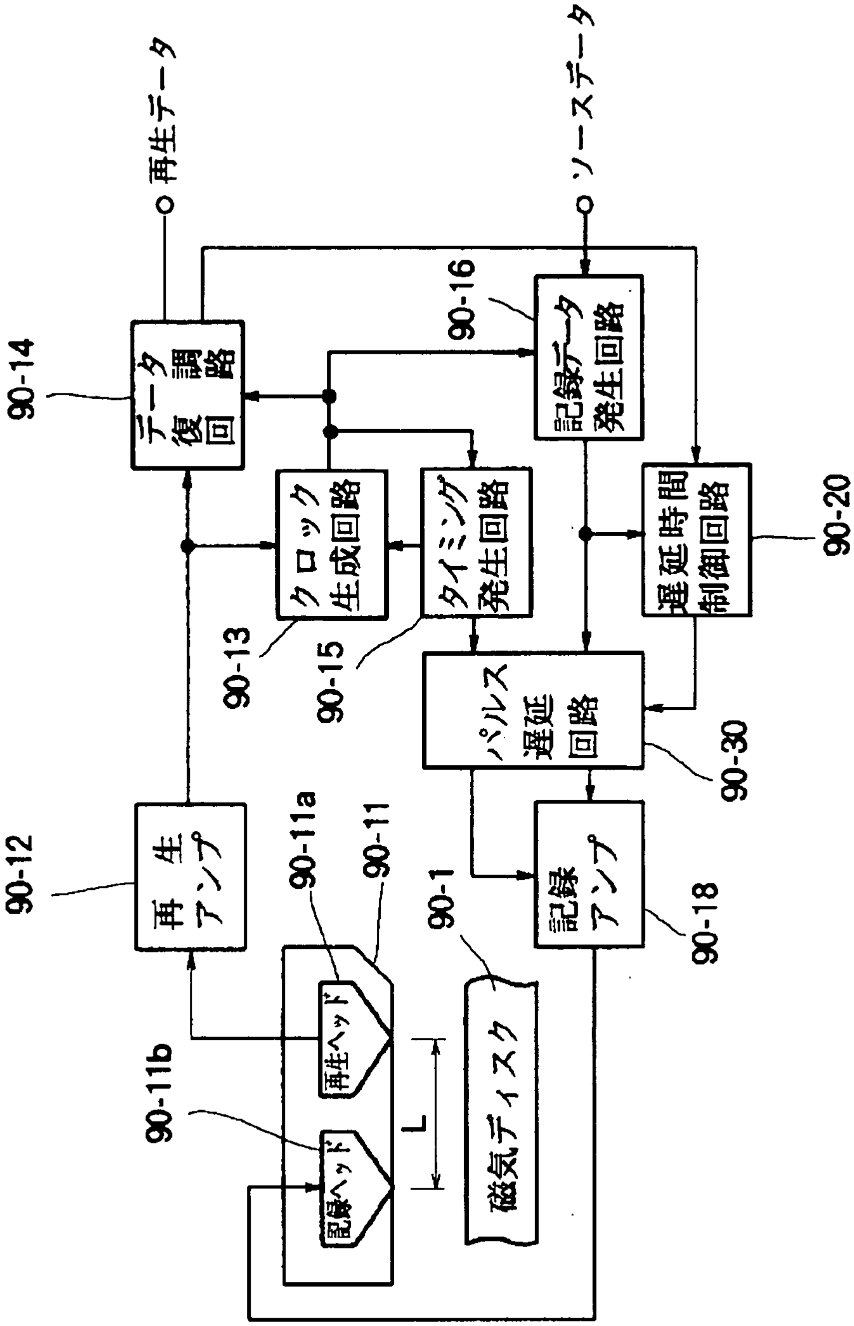
(a)従来の方式



(b)再生回路 80-80 の方式

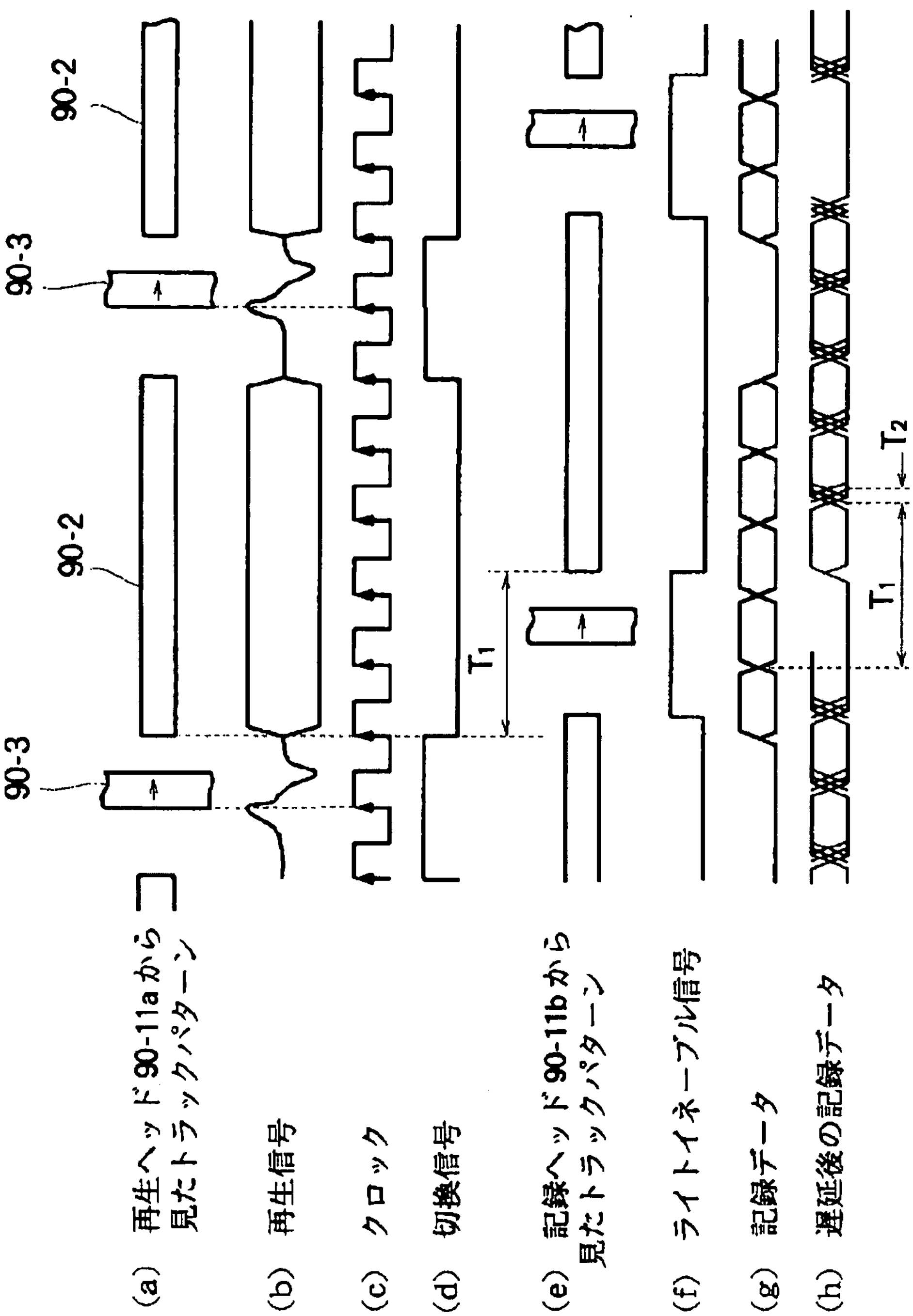


[Drawing 51]

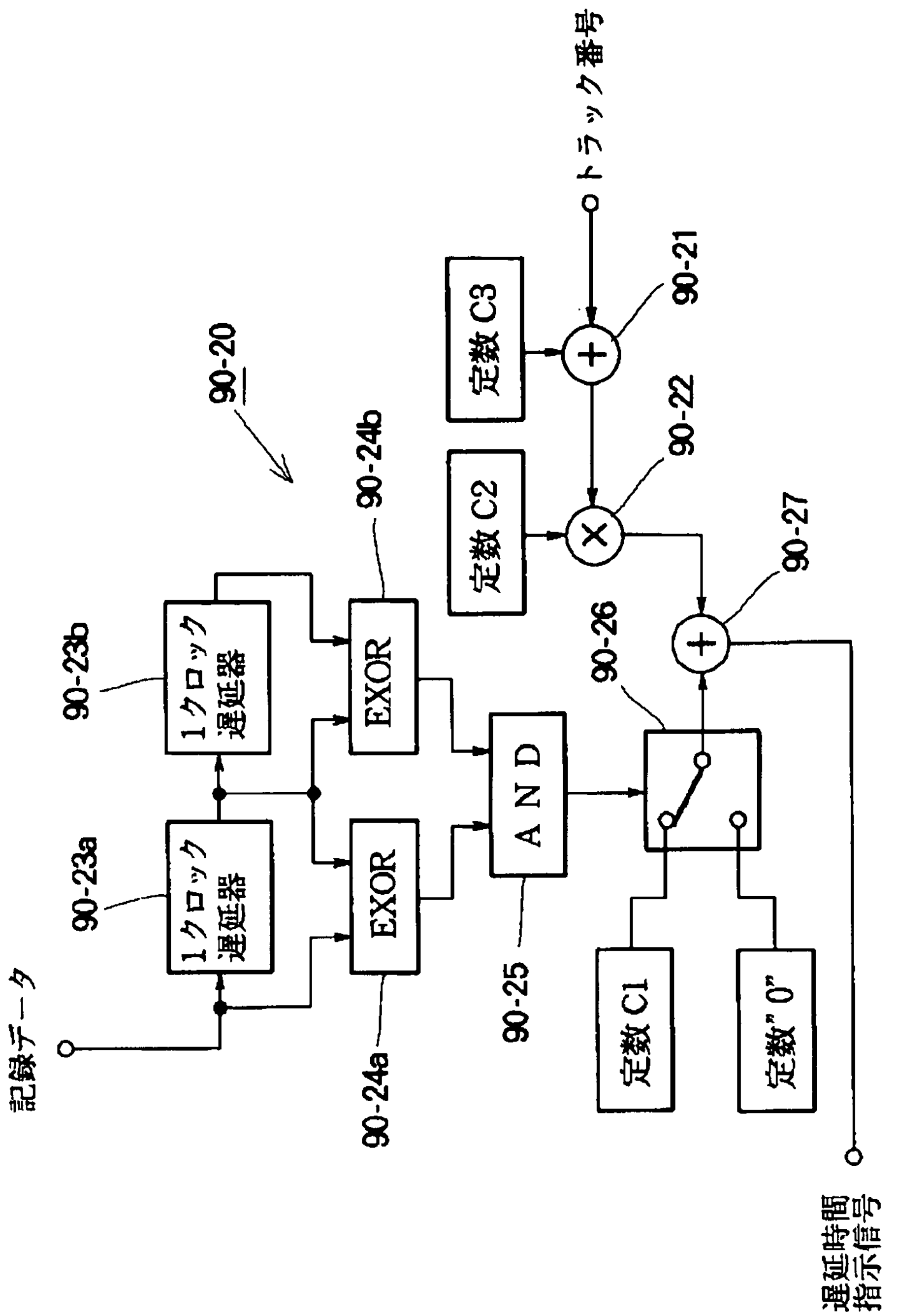


再生データ
ソースデータ
90-14
データ復調回路
90-16
記録データ発生回路
90-13
クロック生成回路
90-15
タイミング発生回路
遅延時間制御回路
90-20
パルス遅延回路
90-30
90-12
再生アンプ
90-11a
90-11
90-1
記録アンプ
90-18
90-11b
再生ヘッド
記録ヘッド
L
磁気ディスク

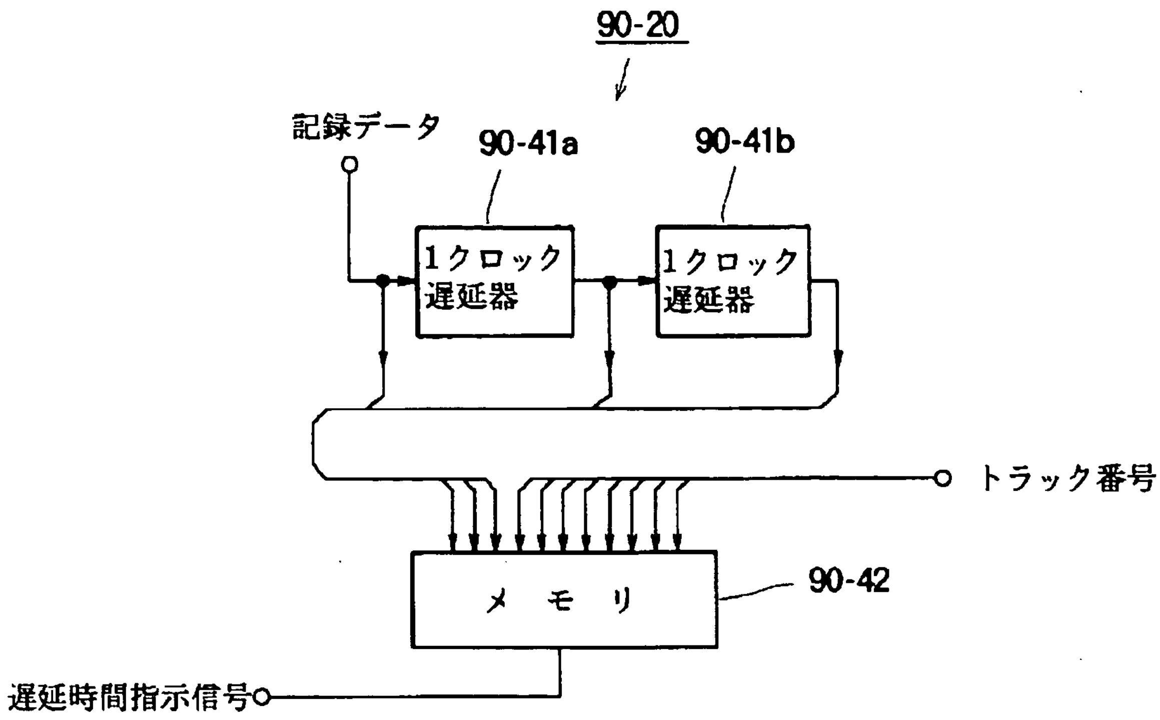
[Drawing 52]


(a) 再生ヘッド90-11aから見たトラックパターン
(b) 再生信号
(c) クロック
(d) 切換信号
(e) 記録ヘッド90-11bから見たトラックパターン
(f) ライトイネーブル信号
(g) 記録データ
(h) 遅延後の記録データ
90-2
90-3
T1
T2

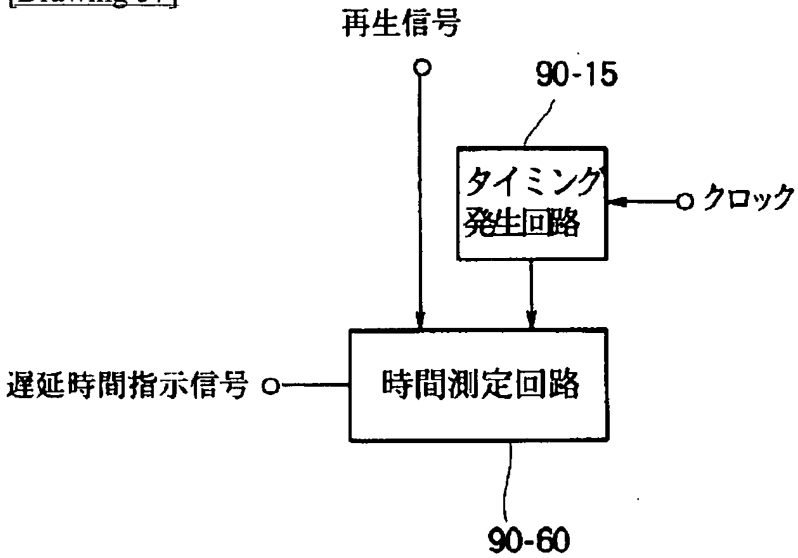
[Drawing 53]


90-20
記録データ
1クロック遅延器
1クロック遅延器
90-23a
90-23b
EXOR
EXOR
90-24a
90-24b
AND
90-25
90-26
定数C1
定数"0"
定数C2
定数C3
90-21
90-22
90-27
トラック番号
遅延時間指示信号

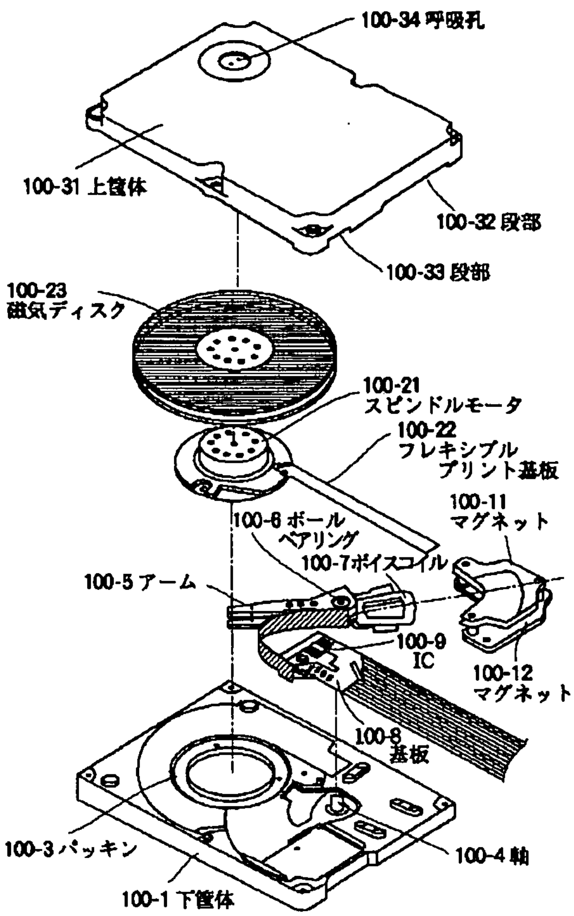
[Drawing 55]



[Drawing 57]



[Drawing 59]



[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) 公開特許公報（Ａ）　(11)特許出願公開番号

特開平11－92971

(43)公開日　平成11年(1999) 4月6日

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Ｇ１１Ｂ　5/127		Ｇ１１Ｂ	5/127	Ｋ
Ｈ０１Ｌ　21/3065		Ｈ０１Ｌ	43/12	
// Ｈ０１Ｌ　43/12			21/302	Ｊ

審査請求　有　請求項の数6　ＯＬ　（全 7 頁）

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(22)出願日　平成9年(1997) 9月22日

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(54)【発明の名称】　反応性イオンエッチング用のマスク

(57)【要約】

【課題】　生産性に優れ、加工精度の高い磁性材料のエッチングを可能とする。

【解決手段】　プラズマによる反応性イオンエッチングのためのマスクであって、チタン、マグネシウム、アルミニウム、ゲルマニウム、白金、パラジウムおよびこれらの各々の、もしくは２種以上を主成分とする合金、あるいは化合物のうちの少くとも１種で構成する。

【特許請求の範囲】

【請求項１】　プラズマによる反応性イオンエッチングのためのマスクであって、チタン、マグネシウム、アルミニウム、ゲルマニウム、白金、パラジウムおよびこれらの各々を、もしくは２種以上を主成分とする合金あるいは化合物のうちの少なくとも１種で構成されていることを特徴とする反応性イオンエッチング用のマスク。

【請求項２】　一酸化炭素と含窒素化合物との混合ガスのプラズマによる反応性イオンエッチング用マスクである請求項１のマスク。

【請求項３】　磁性材料をエッチングする際の反応性イオンエッチング用マスクである請求項１または２のマスク。

【請求項４】　一酸化炭素と含窒素化合物との混合ガスのプラズマによる反応性イオンエッチングのためのマスクであって、シリコンまたはシリコンを主成分とする合金で構成されていることを特徴とする反応性イオンエッチング用のマスク。

【請求項５】　一酸化炭素と含窒素化合物との混合ガスのプラズマによる反応性イオンエッチングのためのマスクであって、シリコンの化合物で構成されており、レジスト膜からのパターンの上に配設されてリフトオフによりマスクとされることを特徴とする反応性イオンエッチング用のマスク。

【請求項６】　磁性材料をエッチングする際の反応性イオンエッチング用マスクである請求項４または５のマスク。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この出願の発明は、反応性イオンエッチング用マスクに関するものである。さらに詳しくは、この出願の発明は、磁気ディスクへの書き込み読み出しに用いられる磁気ヘッド、磁気集積回路に組み込まれるマイクロトランス、マイクロインダクター、磁気センサー、さらにスピン散乱磁気抵抗効果素子、スピンバルブ素子、強磁性トンネル接合素子、スピン電界効果素子、スピンダイオード、スピントランジスターなどの一群の量子効果磁気デバイス、また薄膜磁石、磁歪アクチュエーターなどの微少機械の構成部品などの製造に有用な、磁性材料のドライエッチング装置等として特徴づけられる、新しい反応性イオンエッチング用マスクに関するものである。

【０００２】

【従来の技術とその課題】一般に超ＬＳＩ等の微小半導体素子や磁気素子はリソグラフィー技術とエッチング技術という２つのプロセスを組み合わせて製造されている。リソグラフィー技術は被加工物質（半導体の薄膜や磁性体の薄膜）の表面に塗布したレジスト膜等の感光膜に微細図形を作る技術であり、これには紫外線を用いて感光させるフォトリソグラフィ技術、電子線を用いて感光させる電子線リソグラフィ技術、さらにイオン線を用いて感光させるイオン線リソグラフィ技術がある。

【０００３】また、エッチング技術は、リソグラフィで作製したレジストパターンを被加工物質の半導体薄膜や磁性体薄膜に転写し、素子を作製する技術である。エッチング技術には、湿式エッチング法、アルゴンイオンミリング法、及び反応性イオンエッチング法がある。これらのエッチング方法の中で、反応性イオンエッチング法は、リソグラフィーで作製したパターンを最も正確に転写することができ、微細加工に最も適しており、かつエッチング速さが速く、最も優れた方法である。現実に半導体の大規模集積回路、半導体メモリーがこの方法により作られている。

【０００４】反応性イオンエッチング法は反応性ガスのプラズマ中に被加工物を置き電界を加えることにより、被加工物の表面に対して垂直に入射するイオンにより、化学的並びに物理的に被加工物の表面の原子を順次はぎ取る方法であり、マスクで覆われていない個所を、マスクの境界に沿って垂直に切り込んでいく異方的な加工が可能である。そのために微細な鋭い形状の転写が可能な方法である。反応性イオンエッチング法では、プラズマ中で発生した反応性ガスのイオン、ラジカルなどの化学的活性種が被加工物の表面に吸着し、被加工物と化学反応をし、低い結合エネルギーをもつ表面反応層がまず形成される。そこで、被加工物の表面はプラズマ中で電界で加速された正イオンの垂直の衝撃にさらされているわけであるから、結合が緩んだ表面反応層はイオンのスパッタリング作用により、あるいは蒸発作用によりはぎ取られていく。このように反応性イオンエッチング法は化学的作用と物理的作用とが同時に起こって進行するプロセスである。そのため特定の物質のみをエッチングするという選択性が得られ、同時に加工対象物質の表面に垂直に切り込んでいくという異方性が得られるわけである。

【０００５】しかしながら、一方で、磁性材料に対しては、長い間有効な反応性イオンエッチング法が見つからず、現実には磁性材料に対しては、湿式エッチング法とアルゴンイオンミリング法が用いられ、それにより薄膜磁気ヘッド、磁気センサー、マイクロトランスなどが製造されている。磁性材料におけるこのような状況は、磁性体の微細化並びに高密度集積化の指向を半導体に比べて著しく遅らせ、発展の障害となっていた。

【０００６】磁性材料に対する反応性イオンエッチングが困難な理由は、遷移金属元素を主成分としている磁性材料は、今まで半導体材料用に開発されてきたすべてのエッチングガス（例えばCF_4，CCl_4，CCl_2F_2，$CClF_3$，$CBrF_3$，Cl_2，C_2F_6，C_3F_8，C_4F_{10}，CHF_3，C_2H_2，SF_6，SiF_4，BCl_3，PCl_3，$SiCl_4$，HCl，$CHClF_2$ など）は磁性材料とプラズマ中で反応するが、半

導体材料の反応生成物と比較して、はるかに結合エネルギーが大きい物質を生成するので、スパッター作用を受けにくく、したがってエッチングはなされなかった。

【０００７】そこで、半導体技術からの類推ではなく、新しい反応性イオンエッチング反応を探究する努力がなされ、最近本発明の発明者等により一酸化炭素（ＣＯ）ガスとアンモニアガス（NH_3）の混合ガスプラズマを用いる方法が発明された。この方法は、ＣＯの活性ラジカルにより被加工物である遷移金属元素を主成分とする磁性材料の表面で遷移金属カーボニル化物（$Fe(CO)_5$，$Ni(CO)_4$，$Co_2(CO)_8$，$Mn_2(CO)_{10}$，$Cr(CO)_6$，$V(CO)_6$，$Mo(CO)_6$，$W(CO)_6$）を生成させ、真空中での蒸発作用、あるいはイオンによるスパッター作用により、それらをはぎ取り、エッチングすることを原理としている。遷移金属カーボニル化物は遷移金属中で唯一の結合エネルギーが小さい化合物である。しかしながら、プラズマ中でＣＯガスは不均等化反応によりCO_2とＣに分解するため、導入したＣＯガスは反応に寄与することなく、また遊離したＣ原子は遷移金属元素と反応し、安定な遷移金属カーバイドを生成するので、エッチング反応は起こらないのが普通である。NH_3ガスは遷移金属元素の存在下で、上記の不均等化反応を遅らせる性質を示し、ＣＯガスとNH_3ガスをほぼ等量混合したガスのプラズマ中で、目的の反応性イオンエッチングが進行する。

【０００８】この原理に基づく方法で、磁性材料のパーマロイ（Ｆｅ−Ｎｉ合金）、Ｃｏ−Ｃｒ合金、Ｆｅなどの反応性イオンエッチングの実現が確認されている。このように、磁性材料に対する優れた反応性イオンエッチング法が見出されて、今後の技術的発展が期待されているところであるが、従来では、ＣＯ−NH_3混合ガスプラズマによるエッチングのためには、このエッチング反応を受けにくいマスク物質としてスパッタリング法により形成されるSiO_2膜が用いられていたことにより、その加工精度や生産性には制約があるという問題が残されていた。

【０００９】この従来のプロセスを図示すると図２のとおりとなる。出発の形態は図２（ａ）に示すように、コーニング７０５９ガラス基板（１）など適当な基板材料の上に、加工対象物質の磁性合金、例えばパーマロイ（Ｎｉ−Ｆｅ合金）（２）などをスパッタリング法により形成し、その上にマスク材料とする石英（SiO_2）薄膜（３）を、その上に導電材料の例えば非晶質炭素膜（４）をそれぞれスパッタリング法により形成し、さらに電子線感光膜のレジスト（５）を例えばスピンコート法などにより塗布したものである。ここでは非晶質炭素膜（４）は電子線露光する際に対象物質が帯電しないために必要な導電層であり、これはSiO_2（３）が絶縁体であるために必要となる膜である。図２（ｂ）に示すように、電子線描画と現像処理によりレジストに所望の図形を形成する。その後酸素イオンエッチングによりレジスト図形をマスクとして、非晶質炭素層をエッチングし、SiO_2膜を図形に沿って露出させる（図２（ｃ））。次ぎに例えば４フッ化炭素（CF_4）ガスのプラズマを用いて、SiO_2をエッチングし、その図形をSiO_2膜に転写する。CF_4のイオンエッチングはSiO_2のみに有効なため、目的とする加工対象物質のパーマロイには変化を与えない（図２（ｄ））。以上のようにして得られたSiO_2の図形をマスクとして、先に述べたＣＯ−NH_3混合ガスプラズマを用いた反応性イオンエッチング法により、SiO_2に転写された図形をパーマロイに転写する。この過程でレジスト膜、及び非晶質炭素膜も同時にエッチングで取り除かれ、SiO_2がパーマロイの図形の上に残留する形で転写が完了する（図２（ｅ））。今まではこの方法による磁性材料のパーマロイ（Ｆｅ−Ｎｉ合金）、Ｃｏ−Ｃｒ合金、Ｆｅなどの反応性イオンエッチングによる微細加工が行われている。

【００１０】しかしながら、以上のプロセスは、複雑で生産性が悪いという問題点を有しているのみでなく、転写が二回行われるため、転写図形の高い精度が得られないという問題点を有していた。この方法は電子線で露光されなかった部分に対応した図形を最終的に残すという方法であり、結果的に電子線で露光した図形を反転した図形、すなわちネガ図形を与えるものである。しかしながら、磁性体の複雑な微細な構造体を作製する過程においては、電子線露光した部分に対応した図形（ポジ図形）を得ることも必要とされているのである。

【００１１】この出願の発明は、従来技術のこのような問題を解決するものとしてなされたものであって、簡便でかつ高い分解能と高い精度でエッチングを可能とし、同時にポジ図形を作製することを可能とする新しいマスク材料とこれを用いたプロセス技術を提供することを目的としている。

【００１２】

【課題を解決するための手段】この出願の発明は、上記の課題を解決するものとして、プラズマによる反応性イオンエッチングのためのマスクであって、チタン、マグネシウム、アルミニウム、ゲルマニウム、白金、パラジウムおよびこれらの各々を、もしくは２種以上を主成分とする合金あるいは化合物のうちの少なくとも１種で構成されていることを特徴とする反応性イオンエッチング用のマスク（請求項１）を提供する。

【００１３】また、この発明は、上記マスクについて、一酸化炭素と含窒素化合物との混合ガスのプラズマによる反応性イオンエッチング用のマスクであること（請求項２）、磁性材料をエッチングする際の反応性イオンエッチング用マスクであること（請求項３）も提供する。さらにまた、この出願の発明は、一酸化炭素と含窒素化

合物との混合ガスのプラズマによる反応性イオンエッチングのためのマスクであって、シリコンまたはシリコンを主成分とする合金で構成されていることを特徴とする反応性イオンエッチング用のマスク（請求項４）と、同様に一酸化炭素と含窒素化合物との混合ガスのプラズマによる反応性イオンエッチングのためのマスクであって、シリコンの化合物で構成されており、レジスト膜からのパターンの上に配設されてリフトオフによりマスクとされることを特徴とする反応性イオンエッチング用のマスク（請求項５）、並びに、これらを磁性材料をエッチングする際の反応性イオンエッチング用マスクとすること（請求項６）も提供する。

【００１４】

【発明の実施の形態】従来主として半導体技術で用いられているマスク物質は高分子材料であるレジスト自身である。しかしながら各種の高分子レジストはCO－NH_3 ガスプラズマ中において消耗が大きくマスクとしての役割を果たさない。Cr，W，Mo，Mn，Nb，Ta，Fe，Ru，Os，Co，Rh，Ir，Ni，Cu，Ag，Au，Ga，In，Snなど金属元素及びそれらを主成分とする合金並びに化合物はCO－NH_3 ガスプラズマと反応し、スパッタリング作用によりそれら自身がエッチングされ、消耗するのでマスク材料としては適さない。またZn，Cd，Pbあるいはそれらを主成分とする合金あるいは化合物は耐真空性が悪くマスク材料として適さない。一方、Ti，Mg，Al，Si，Ge，Pt，並びにPd及びそれらを主成分とする合金あるいは化合物はCO－NH_3 ガスプラズマと反応しにくく、マスク材料として好適であることが実験の結果明らかになった。それらの中で、化学的安定性、結晶粒の緻密さ、ピンホールのでき難さなどの用件から、最も望ましい物質はTi及びTiを主成分とする合金あるいは化合物であった。

【００１５】そこで、この発明では、前記のとおりTi，Mg，Al，Ge，Pt，Pdおよびそれらの各々もしくは２種以上を主成分とする合金、もしくはその化合物の少くとも１種によってマスクを構成する。つまり、Ti，Mg，Al，およびGeやPt，Pdの各々の単体金属、Ti合金、Mg合金、Al合金、Ge合金、Pt合金、Pd合金、Ti－Mg合金、Ti－Al合金、Ti－Ge合金、Ti－Pt合金、Ti－Pd合金、Mg－Al合金、Mg－Ge合金、Mg－Pt合金、Mg－Pd合金、Al－Ge合金、Al－Pt合金、Al－Pd合金、Ge－Pt合金、Ge－Pd合金、Ti－Mg－Al合金、Ti－Al－Ge合金、Ti－Mg－Ge合金、Ti－Mg－Pt合金、Ti－Al－Pd合金、Mg－Al－Ge合金、TiO_2 、MgF_2 、Al_2O_3 、TiN、AlN、MgN，GeO_2 、PdO等のうちの少くとも１種によりマスクを構成する。この場合の「少くとも１種」との規定は、マスクの全体がこれらのうちの１種のみによって構成されてもよいし、その部分複合により、あるいはその積層により、さらにはマスクの露出している表面層が複数種によって構成されてもよいことを意味している。

【００１６】そしてまた、この発明では、シリコンまたはシリコンを主成分とする合金、さらにはSiO_2 ，Si_3N_4 等の化合物もマスクとすることができる。シリコンの合金については、前記のTi，Mg，Al，Ge等との組合わせとすることが好ましいものとして例示される。たとえばTi－Si合金、Si－Al合金、Si－Ge合金、Si－Pt合金、Si－Pd合金、Ti－Si－Al合金、Ti－Mg－Si合金、Al－Mg－Si合金等が例示されることになる。

【００１７】SiO_2 については、マスクとしての使用がこれまでに検討されているが、これまでは、２段転写の方法である。これに対して、この発明ではリフトオフによる新しいマスクとして使用する。これらのマスクは、真空蒸着、スパッタリングやイオンプレーティング、イオンビーム蒸着等の各種手段によって形成することができる。

【００１８】この発明のマスクについて、微細加工のプロセスとして例示すると図１のとおりとなる。図１（a）に示すとおり、微細加工プロセスの出発は加工対象である磁性薄膜（２）はコーニング７０５９ガラスなど適当な基板材料（１）の上に形成し、その上にレジスト膜（５）を例えばスピンコート法で形成したものである。この多層膜を電子線露光し、現像し、レジスト膜（５）に所望のパターン（６）を形成する（図１（b））。その後、マスク物質、例えばTi（７）を真空蒸着し、リフトオフ法、すなわち高分子レジストを溶解しTiマスク（８）を形成する（図１（d））。次ぎにCO－NH_3 混合ガスプラズマによる反応性イオンエッチング法により、磁性体の薄膜のTiマスクで覆われていない個所だけを取り去ることにより、磁性体薄膜にパターンが形成される（図１（e））。微細加工を施した磁性体（９）を得る。なお、この過程ではTiのマスクは除去されないまま残るので、Tiマスクを除去したいときには、例えばCCl_4 ガスプラズマを用いる従来法の反応性イオンエッチング法により、残留したTiマスクを除去する（図１（f））。

【００１９】いずれの場合にも、この発明によって、エッチング対象物質に対する汚染物質の再付着は認められず、鋭く正確な形状のエッチングが可能となる。なお、この発明が対象とする被エッチング物質については、以上のとおりの磁性材料を代表的なものとし、この磁性材料については、パーマロイをはじめ、遷移金属を主成分とする磁性材料、たとえばFe，Ni，Co，Co－Cr合金、センダスト合金、Mo，希土類これら元素の合金や化合物の各種のものでよい。

【００２０】また、マスクパターン形成のためのレジス

ト膜を用いる場合には、従来と同様の露光現象による有機ポリマー膜の各種のものが用いられる。もちろん、直接的なマスク形成であってもよい。エッチングのためのプラズマ用ガスは、磁性材料を対象とする場合、前記のようにＣＯガスとNH_3またはアミン類の含窒素化合物ガスの場合が好適に用いられる。

【００２１】以下、実施例を示し、さらに詳しく説明する。

【００２２】

【実施例】

実施例１（Ｔｉマスク）

図１に示すプロセスに従い反応性イオンエッチング装置を用いた。エッチングの試料として、コーニング７０５９ガラス基板（１）上にスパッタリング法で磁性材料薄膜（２）としての厚さ４５０ｎｍのＦｅ薄膜を形成し、その表面に電子線リソグラフィーとリフトオフ法により、レジスト膜（５）から形成されたパターン（６）の上に、マスク材料（７）としてＴｉを用い、微小な多数のＴｉパッドを形成してマスク（８）として用いた。その試料を、水冷を施した１３．５６ＭＨｚの高周波を印可する下部電極上に置き、高周波電極とそれと対向した接地電極の距離を３５ｍｍとした。ＣＯガス及びNH_3ガスを、それぞれ６．３ｃｃ／ｍｉｎ、及び６．８ｃｃ／ｍｉｎの流量で反応容器に供給しながら、ターボ分子ポンプにより排気し、内部を5.7×10^{-3}Ｔｏｒｒの圧力に保持した。試料を保持した下部電極に電極単位面積当たり$3.7W/cm^2$の高周波を印可し、$CO-NH_3$混合ガスのグロー放電プラズマを発生させ、反応性イオンエッチングを行った。エッチング時間は４．０分間とした。エッチング反応後、マスク（８）として用いたＴｉパッドに覆われている個所と、覆われていない個所の間に生じた段差を繰り返し反射干渉計で測定し、単位時間当たりのエッチング量を求めた。またエッチングにより生じた形状を電子顕微鏡で観察し、段差の平滑性と鋭さ、ならびに汚染物質や再付着物質の有無に着目してエッチングの評価を行った。微細加工した磁性体（９）としてパターニングされたＦｅ薄膜を得た。　その結果、Ｆｅ薄膜に対するエッチング速さは９０ｎｍ／ｍｉｎであった。また曲率半径が約０．１μｍの鋭さで、深さ４００ｎｍの形状を作製することができた。

【００２３】たとえば図３（ａ）（ｂ）（ｃ）はＴｉマスクとした場合の

（ａ）　Ｆｅ薄膜

（ｂ）　Ｃｏ－９．８％Ｃｒ薄膜

（ｃ）　Ｎｉ－２０％Ｆｅ薄膜

のエッチングの結果を例示した電子顕微鏡写真であり、優れた加工精度が得られていることがわかる。

実施例２（Ａｌマスク）

実施例１と同様な条件で、Ａｌを真空蒸着し、リフトオフ法により、Ａｌマスクを作製し、Ｎｉ－Ｆｅ２０％Ｆｅ合金の反応性イオンエッチングが可能であった。エッチングの速さは１２０ｎｍ／ｍｉｎであり、またエッチングの形状は同様に良好であった。

実施例３（Ｓｉマスク）

実施例１と同様な条件で、Ｓｉを真空蒸着し、リフトオフ法により、Ｓｉマスクを作製し、Ｃｏ－９．８％Ｃｒ合金の反応性イオンエッチングが可能であった。エッチングの速さは１４０ｎｍ／ｍｉｎであり、エッチングの形状は同様に良好であった。

実施例３（Ｇｅマスク）

実施例１と同様な条件で、Ｇｅを真空蒸着し、リフトオフ法により、Ｇｅマスクを作製し、Ｃｏ－９．８％Ｃｒ合金の反応性イオンエッチングが可能であった。エッチングの速さは１４０ｎｍ／ｍｉｎであり、エッチングの形状は同様に良好であった。

【００２４】

【発明の効果】この発明の反応性イオンエッチング装置を用いることにより、磁性合金を対象とした$CO-NH_3$混合ガスプラズマを用いる反応性イオンエッチングは従来型反応性イオンエッチング装置を用いた場合に比べて、より効果的になる。すなわち、磁性合金に対するエッチング速さは同一のエッチング条件の下で、約４倍になり、作業効率の向上に寄与する。またエッチング対象物質がエッチングプロセスにおいて、汚染されることがなく、エッチングにより除去された物質の再付着も問題にならない程度に少なくすることができる。以上のような作用効果により、磁気記録用の微細磁気ヘッド、マイクロトランス、マイクロ磁気素子、磁気センサー、磁気抵抗効果素子、スピンダイオードやスピントランジスター、スピンバルブ素子、スピンバルブ磁気メモリー、トンネル磁気抵抗効果素子などの製造が可能となる。また将来の高密度磁気記録媒体のパターンド磁気記録媒体なども製造が可能となる。

【図面の簡単な説明】

【図１】この発明による磁性材料の微細加工のプロセス図である。

【図２】従来技術による磁性材料の微細加工のプロセス図である。

【図３】（ａ）（ｂ）（ｃ）は、各々、エッチング後の状態を例示した図面に代わる電子顕微鏡写真である。

【符号の説明】

１　基板物質

２　磁性材料薄膜

３　酸化シリコン（SiO_2）膜

４　非晶質炭素膜

５　レジスト膜

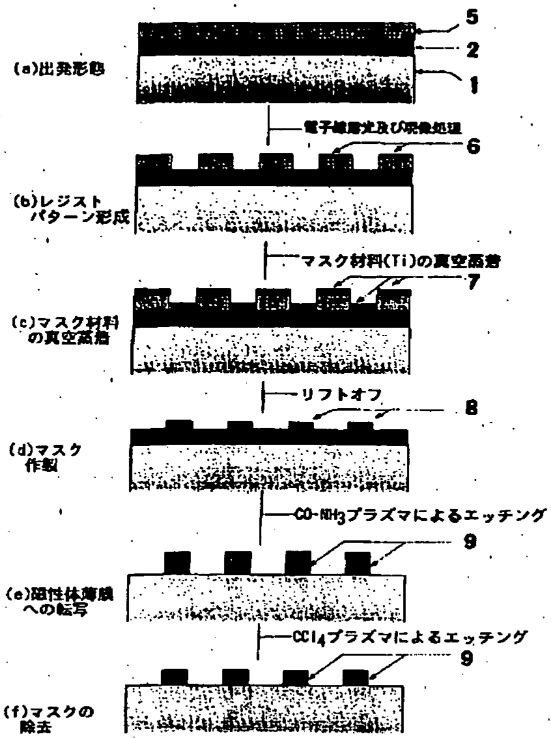
６　レジストパターン

７　真空蒸着したマスク材料

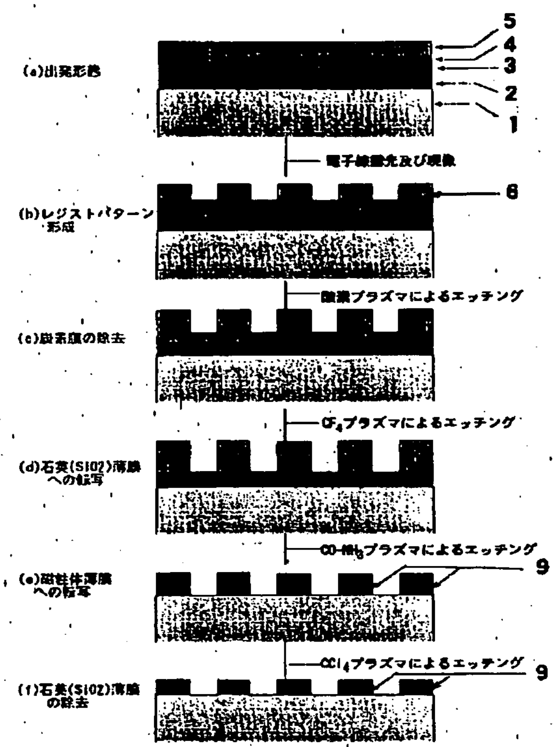
８　マスク

９　微細加工を施した磁性体

【図1】



【図2】



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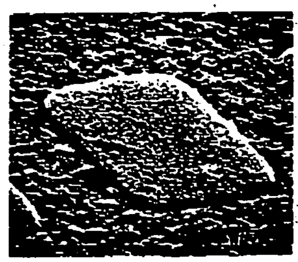
【図3】



(a)

(b)

(c)